THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XXXII DECEMBER, 1934 No. 6

THE TREATMENT OF CANCER OF THE PHARYNX, TONSIL AND EXTRINSIC LARYNX BY DIVIDED DOSES OF EXTERNAL RADIATION*

By

HAYES E. MARTIN, M.D., F.A.C.S.
Attending Surgeon, Memorial Hospital
NEW YORK CITY

and

ROBERT F. McNATTIN, M.D.
Formerly Fellow in Cancer Research, Memorial Hospital
WILMINGTON, DELAWARE

THE "divided dose," "protracted dose" or "fractional dose" method of irradiation has been employed in varied manners for many years. Any method in which less than a maximum dose is given in one sitting and repeated one or several times at fairly short intervals might logically be called a divided dose method. But, as a matter of fact, most such techniques have been empirical and the time intervals entirely arbitrary, chosen to suit the convenience of the patient and radiologist, especially where multiple skin portals were employed.

Pfahler's saturation technique is a fractional dose method based largely on the theory that there is a loss of radiation effect at a definite rate and that by daily repetition of a certain percentage of the original dose, this loss is replaced so that the original effect is maintained or prolonged for a desired period.

Since 1920, Coutard[1] has employed a divided dose technique based on the theory that the effect of multiple daily doses of external irradiation was cumulative and that there should be a steadily increasing radiation effect brought to a climax after two to four weeks of treatment. The total doses employed by Coutard were much larger than those given by any other method of external irradiation. Such intense biological effects as a blistering or epidermicidal reaction of the skin and a membranous mucositis in the pharynx were deliberately produced as a requisite to secure a lethal effect on the underlying tumor. It was also demonstrated by Coutard that these biological effects on the skin and mucosa produced by such a technique invariably healed without difficulty. This theory also holds that by such repetition of daily doses, there is a greater differential effect as between normal and neoplastic tissue than if one or only a few massive doses be given at longer intervals.

This divided dose technique for the treatment of pharyngeal cancer or cancer in general has not been as widely emphasized as its merits deserve, the main

* Read before the American Congress of Radiology, Chicago, Ill., Sept. 25-30, 1933.

reason probably being the difficulty in translating the technique into terms applicable in dissimilar therapeutic apparatus. In any form of radiation therapy there are so many variable factors in any technique that it is often impossible and usually inadvisable to attempt an exact duplication except within one institution where the same equipment is always available. In other words, we believe that success may be obtained by a divided dose technique with considerable variation in voltage, milliamperage, distance, filter, etc., provided that an adequate tissue dose is delivered to the tumor by accurately directed repeated doses over a period of two to four weeks or sometimes longer. It is therefore necessary, in describing a method, to define its essential features, permitting any other radiologist to attain the same effects by his own equipment. The measurement of x-ray dosage in roentgens has been of paramount importance in simplifying the description of a technique.

We believe the essential features of the divided dose technique as used by Coutard to be as follows:

(1) The treatments should be given daily and should be of equal quantity unless the clinical course indicates a raising or lowering of the daily doses.

(2) A total treatment period of a definite length (15–20–30 days, etc.) should be decided upon, in which to deliver a certain total dosage. This treatment period should be adhered to unless the clinical course indicates that it should be shortened or lengthened.

(3) In most cases of intraoral or pharyngeal cancer, the total biological effect produced must be close to the local and general tolerance in that definite blistering of the skin and a mucositis must be produced in order to approach a lethal effect on most tumors.

The best plan of procedure in the various types of neoplasms in various localities is not as yet definitely settled and we have felt it advisable to evaluate separately the most important factors such as the size of the individual and of the total dose, the length of the treatment period, the number and size of the skin portals, the filter, etc., in order to form any accurate opinion. We have therefore followed for considerable periods, what to many may seem arbitrary technique in which all factors were fixed except one.

At the Memorial Hospital, prior to 1931, we had been able to secure permanent regression of pharyngeal carcinoma by external irradiation alone in a few instances. These cases had been given repeated doses of external irradiation usually by a combination of radium and roentgen rays over a period of ten to fifteen days. However, the spacing and the amounts of the individual treatments were so irregular that it was difficult or practically impossible to duplicate a technique. No two cases had received exactly the same form of treatment.

At the beginning of 1931, we therefore decided to outline a definite general form of treatment for divided doses with roentgen rays at 200 kv. in which all factors were to be fixed except the size of the skin portal and the amount of the daily dose. Under this plan, a treatment period of two weeks was chosen in which to deliver 12 treatments (omitting Sundays). This treatment period (two weeks) was adhered to as closely as possible throughout 1931 after which it was lengthened to twenty to thirty days. We began with portals varying from 48 sq. cm. to 150 sq. cm. and a daily dose of 250 r (measured in air) applied to alternate sides of the pharynx for a total of 1,500 r to each side of the neck in two weeks. We soon learned that this total dose was far below the local and general tolerance and was not followed by complete regression in the cases treated. We then increased the daily dose gradually to 400 r (total—2,400 r to each side in fourteen days), and at this point felt that with the fairly large skin portals (80–100 sq. cm., on the average) about the limit of local and general tolerance had been

reached. We extended this dose to 3,000 r×2* in a few cases with what seemed to be too great a local and general effect. Since 1931, we have increased the treatment period to twenty days or more and have decreased the skin portal size where it seemed justified. This question will be discussed at greater length under a description of the technique.

SELECTION OF CASES

In our clinic, all ambulatory cases of cancer are accepted for at least palliative treatment and therefore the series of cases herein reported have not been selected according to the stage of the disease. A majority have shown metastatic involvement to the cervical nodes at the time of admission. The clinical types of disease best suited to the divided dose method of external irradiation are the following:

1. Tonsil
2. Soft palate
3. Pharyngeal walls
4. Nasopharynx
5. Extrinsic larynx
6. Base of tongue
7. Intrinsic larynx
8. Anterior floor of mouth

Growths of these regions are apt to include a higher percentage of such radiosensitive types as lympho-epithelioma and transitional cell carcinoma. Pharyngeal tumors in general, despite their histological character, are more often radiosensitive than those of the adjacent oral cavity, intrinsic larynx or esophagus. Lesions of the cheek (buccal mucosa), alveolar ridges, anterior portion of the tongue and hard palate tend to be more adult in character and less radiosensitive. In a few instances, we have secured complete regression of carcinoma of the antrum and carcinoma of the cheek by divided doses of external irradiation alone. However, these cases are too few in number or too recent to deserve a report at this time. Growths of all the anatomical locations listed above are inaccessible to surgical removal except for the tonsil and intrinsic larynx, and therefore the indications for radiation therapy as the primary treatment are clearly indicated. With the exception of the tonsil and intrinsic larynx, even interstitial irradiation is difficult and unsatisfactory. Tonsillar growths, though surgically accessible, yield poor results by surgery. It must be admitted that surgical removal of early cancer of the intrinsic larynx by hemilaryngectomy or total laryngectomy has produced excellent results, although the operations always cause partial or total loss of function of the larynx. Whether the divided dose method of external irradiation is justified in operable cancer of the intrinsic larynx is, we believe, as yet unproved.

We do not believe that infection of the tumor is a contraindication to treatment by the fractional method. Central necrosis of a tumor mass or a pyogenic abscess within the growth before beginning treatment is a disadvantage from the standpoint of the prognosis, but in many cases, offers no alternative for any other method of treatment.

SOURCES OF RADIATION

We have employed, in this investigation, the radiation in general use at Memorial Hospital with no modification except the use of metal cones to obtain accurate-sized circular portals of various sizes.

1. Roentgen rays at 200 kv. (peak); 50–60 cm. distance; filter 0.5 mm. Cu+2.5 mm. Al

* Coutard's method of expressing his total dosage in one figure which he obtains by the addition of the amounts received by each of several portals, we believe to be misleading and confusing. As for instance, if a case has received 3,000 r to each of 2 portals on either side of the neck, Coutard expresses the dose as being 6,000 r. Let us suppose, for example, that a skin portal of 10×20 cm. is given a dose of 3,000 r. If then a similar field were divided in half and each half (10×10 cm.) were given 3,000 r separately, certainly it would be an error to express the dose so given by a figure such as 6,000 r. When the beams cross fire from opposite sides of the neck, the actual dose received by the skin is not expressed by stating the strength of the incident beam, because of the additional amount delivered by the radiation which has passed entirely through the neck. It is, however, certainly not expressed by giving a grand total for the several portals. In fact, such a total is apt to be misleading.

We therefore have adopted the practice of stating the dose received by the individual portal followed by the multiplication sign and the number of portals used. As for instance 3,000 r×2 indicates that 3,000 r was given to each of 2 portals; 3,000 r+3,500 r indicates that 2 portals received the respective amounts specified.

(a) 4 ma. current
(b) 30 ma. current

2. Roentgen rays at 700 kv.; 60 cm. distance; filter 5.0 mm. Cu (equivalent), 5–6 ma. current.

3. Radium element pack. Filter 2.0 mm. lead (equivalent), 10–15 cm. distance; applicator portal 10 cm. in diameter.

Most of our cases have necessarily been treated by roentgen rays at 200 kv. since we have at Memorial Hospital two such treatment units delivering about 42 r per minute at 60 cm., using 30 ma., and four units delivering about 8 r per minute at 60 cm. with 4 ma. The 700 kv. tube delivers about 17 r per minute at 60 cm. The radium element pack contains 4 gm. of radium and for this type of treatment can hardly be practicably used at a greater distance than 10 cm. It is, as yet, not possible to express its output in roentgens, since the measurement of gamma rays in roentgens has not been settled to the satisfaction of all concerned.

As between these three sources of radiation, we have not as yet been able to make any definite comparison as to the effectiveness of the radiation. It has seemed to us that in some instances a greater differential effect on the tumor with less effect on the skin and normal tissues has been obtained with the element pack and 700 kv. unit. We are, at the present time, carrying out experiments with the purpose of determining whether such highly penetrating short wave length will be more effective in these cases than that produced at 200 kv.

FILTRATION

Coutard[1] has employed a filter of 2 mm. Zn + 3 mm. Al in most of his cases. Lenz[2] has employed a filter of 0.5 mm. of silver + 1 mm. Al in some cases and 1.86 mm. of Cu + 1 mm. Al in others. Harrison[3] has employed 1.3 mm. Cu + 1 mm. Al. Zuppinger[4] has apparently followed Coutard's technique exactly. All the above mentioned investigators have used roentgen rays at 180–200 kv.

Most of our cases have been treated by roentgen rays at 200 kv. and a filter of 0.5 mm. Cu + 2.5 mm. Al. In comparing the effects obtained by this filtration with the lesser number of cases treated by our element pack and 700 kv. unit, we are unable as yet to state definitely that the results are in any way superior with the more penetrating types of radiation. Failla and Quimby[5] have shown that the quality of a beam of roentgen rays from 200 kv. is not materially altered *physically* by the addition of a greater filter than 0.5 mm. Cu + 1 mm. Al. Our experience has as yet not demonstrated that there is a difference physiologically. As far as we are concerned, this point remains to be settled. Berven[6] has employed a filter of 4 mm. of lead in his element pack for the treatment of cancer of the tonsil.

SKIN PORTALS

In 1931, we began using open portals from 80–150 sq. cm. in area. The skin portal must obviously include the primary lesion and all cervical metastases within the range of the primary beam. One of the advantages of a large skin portal is the assurance that all foci of the disease are included. We soon discovered, however, that there was a definite relationship between the size of portal and the general tolerance with equal doses expressed in roentgens. Since this is true, it seems illogical to use portals 10–12 cm. in diameter in treating a localized lesion alone or with a superimposed metastasis 2 or 3 cm. in diameter. Undoubtedly, a greater tissue dose at a depth is delivered with a larger portal, but in our opinion at too great an expenditure of the tolerance, and we therefore adopted smaller portals more carefully centered over the lesion itself.

We have found that if the beam of radiation is limited by a metal cone attached directly to the tube holder, the beam may be accurately centered and directed over the desired tissue volume. We have constructed a series of those cones (Fig. 1A) varying in size from 4 cm. (diameter) to 10 cm., but have discontinued the use of those less than 7 cm. These

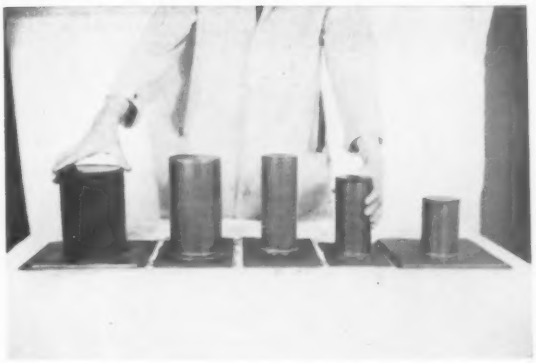


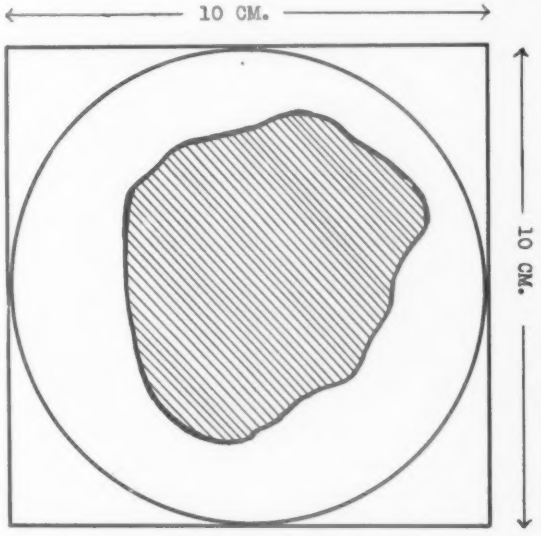
FIG. 1A. Metal cones varying in size from 7–15 cm. in diameter. These cones are attached directly to the tube holder and are of great value in the localization and direction of the beam.

FIG. 1B. A case of carcinoma of the antrum being treated through a metal cone, 7 cm. in diameter.

smaller cones (less than 7 cm. in diameter) seemed too difficult to localize and, with the doses used, produced unsatisfactorily mild reactions. It is possible that, by increasing the dose, such limited portals might be of great practical value. These cones are of practical value for several reasons. Since they are placed in contact with the skin (Fig. 1B), the exact localization of the skin portal is more readily accomplished from day to day, especially if the skin be marked with a dye such as gentian violet. The patient is much less apt to move since the cone placed against the skin tends to steady him, and finally the useful surface area of a circular portal is greater than a square portal.

We recommend the use of circular rather than square or oblong skin portals whenever possible. It must be admitted that for a single lesion in the pharynx, its exact size and extent can hardly be so accurately determined that a square or oblong portal will be more efficient, and that only in the case of irregularly widespread metastases present in the neck can an oblong portal be used to advantage. In Figure 2, we have represented a theoretical lesion to be irradiated by a square and a circular portal of equal diameters. It will be noted that the surface area of the circular portal, which is equally efficient, is 20 per cent less than the square. The tissue volume receiving the direct beam is therefore 20 per cent less with the circular portal which, if equally efficient, should conserve the general tolerance by avoiding damage to outlying normal structures.

In most of our pharyngeal and laryngeal cases, we have used 2 portals only—one to each side of the neck. The addition of a third portal posteriorly, as sometimes used



AREA OF SQUARE - 100 SQ. CM.

AREA OF CIRCLE - 79 SQ. CM.

FIG. 2. The cross-hatched area represents a theoretical tumor to be irradiated by a circular and a square portal, 10 cm. in diameter. The beam, confined by the limits of the square portal, permits of no greater *useful* area than the circular portal. Actually, however, the surface area of the square portal is 20 per cent greater.

by Coutard, we have not found practicable, since most pharyngeal and laryngeal lesions are actually quite close to the anterior portion of the neck in cross section. The expenditure of general tolerance by irradiation from the posterior through the spinal column seems to us unjustified. In some cases of palatal, tonsillar or upper pharyngeal wall carcinoma, we have found it of advantage to use a portal given through the open mouth by the use of a mouth cone, as illustrated in Figure 3. We have constructed several sizes of these cones, the lower edge of which is shaped so as to serve as a tongue depressor.

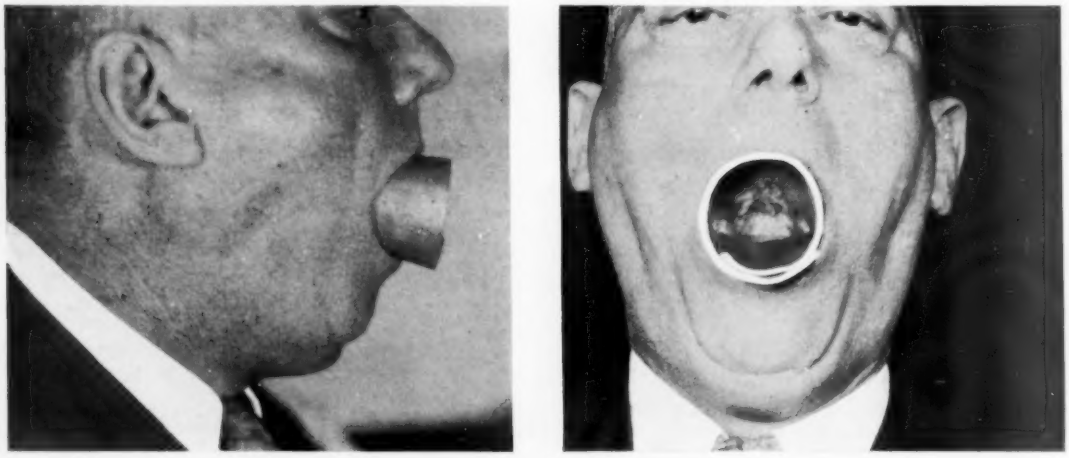


FIG. 3. In irradiating carcinoma of the soft palate, and in some cases of the pharyngeal wall or tonsil, a third portal is used through the open mouth, using a metal cone as illustrated above.

In lesions of the posterior nasopharynx, we use 4 portals if there are metastases to the neck. (These are usually present in nasopharyngeal growths as the first symptoms noted by the patient.) One portal 7–8 cm. in diameter is used to each cheek directed backward and slightly mesially toward the posterior nasopharynx, avoiding the orbits if possible, or protecting them by small lead shields. The third and fourth portals are directly opposed on either side of the neck so as to crossfire the metastases.

In irradiating cancer of the anterior floor of the mouth, 3 portals may be used, one to each cheek and one to the submental region, all directed so as to crossfire the primary lesion.

The maxillary antrum is usually irradiated through one portal, although, in some cases, it is of advantage to use 2 contiguous square or oblong portals to the same cheek.

The selection of the size and number of skin portals will depend on the clinical setting and topography of the individual case. This determination should be made on an anatomical and physical basis after careful examination to determine the exact size and location of the various foci of the growth.

TECHNIQUE

The first requisite in outlining treatment in a given case is the careful localization of the tumor. This, we believe, is best accomplished by indirect mirror examination. By this means the whole hypopharynx or nasopharynx is brought under vision and the extent and limitations of the primary lesion can be accurately determined. For the examination of the posterior nasopharynx, we use the soft palate retractor illustrated in Figure 4. A biopsy is taken at the time of this first examination and we have found that unless the growth is at the glottis or below, it can best be taken by a curved instrument forceps guided by indirect mirror examination rather than by direct laryngoscope. Biopsies from the intrinsic larynx and

pyriform sinuses usually require direct laryngoscopy. From the posterior nasopharynx, a biopsy can readily be obtained by the use of the soft palate retractor and indirect mirror, inserting a straight biopsy forceps directly back through the naris.

By the help of the palpating finger, the exact situation of the underlying tumor is marked on the skin of the neck by a dye such as gentian violet. The relationship of any metastasis is then determined so that the skin portal will amply include both primary growth and metastasis. The size and shape of the skin portal, the direction of the beam and the daily dose are then decided upon. At the present time, we aim at a treatment period of about twenty days, extending it and the total dose if the clinical course and local and general tolerance so indicate.

With portals of 7–10 cm. in diameter (40 sq. cm. to 80 sq. cm.) we begin with a treatment of 350–400 r (measured in air) daily to alternate sides of the neck so that at the end of 20 treatments, the patient has received 3,500–4,000 r to each side. It will be noted that this total dosage is higher than that which can be given in two weeks, where we have found that 2,400–3,000 r is about the limit of local and general tolerance. In the use of the 700 kv. machine (filter 5 mm. Cu (equivalent)) 400–450 r daily is given, totalling 4,000–4,500 r. With the element pack, we give about 10,000 mg-hr. daily (cone 10 cm. in diameter) for a total of 100,000 mg-hr. in three weeks.

The cases are examined daily and any variations from the technique originally decided upon will depend on the clinical course. At the end of fifteen to twenty days in some cases, it will be found that less than the expected reaction has occurred in both normal and neoplastic tissues. In such cases, the daily dose may be raised or the treatment continued beyond the twenty-day period. In other cases, the reaction may be unusually early and marked, accompanied by rapid regression of the tumor. In these cases, the daily dose may be lowered or treatment discontinued before the original plan is completed. In most cases, however, it is best to err on the side of heavy treatment, since we have found that a marked reaction is usually followed by prompt healing and excellent regression of the tumor.

We see no advantage in deliberately interrupting the treatment so as to give the patient several days' rest before completing the original plan, as is recommended in some cases by Coutard. When unusually severe reactions develop, or in the case of a surgical complication such as tracheotomy, the daily sequence of treatments must necessarily be temporarily discontinued. However, we favor an uninterrupted series of daily treatments in all cases if possible. (In our roentgen therapy clinic, no treatments are given on Sundays or holidays.) If only one portal is used, we ordinarily give treatments on alternate days but only as a matter of convenience. It seems to us that a rest period of several days during the treatment period is bound to introduce an unnecessary element of empiricism and uncertainty which has always been a drawback to scientific radiation therapy. If the necessity for interrupting treatment arises too often, it indicates that the daily doses have been too high.

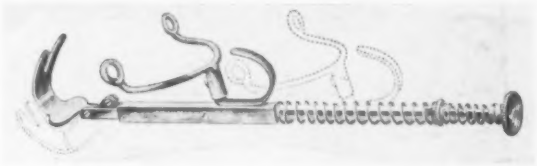


FIG. 4. Soft palate retractor used in the examination of the posterior nasopharynx. This instrument we have found to be indispensable for obtaining the best exposure.

CLINICAL COURSE

Even the first few treatments are apt to be followed by definite clinical symptoms. The patient may complain of a sense of fullness or tension in the tissues directly under the skin portal, especially

in the submaxillary regions. These effects are undoubtedly due to an active congestion of the local tissues and usually disappear within a few hours following treatment. Within two or three days, there begins a dryness of the mucous membranes with a lessening of the amount and an increase in the viscosity of the saliva. This latter symptom increases throughout the treatment and continues for several months following its completion. With doses such as outlined above, there begins in anywhere from six to ten days a mucositis of the pharynx, most commonly first in the soft palate, the arytenoids or the aryepiglottic folds. This increases steadily throughout the treatment and usually goes on to the development of a false membrane of diphtheritic appearance which may cover the mucosa of the entire pharynx. This lesion is quite tender and bleeds slightly but easily if its membrane is disturbed. It reaches its maximum about twenty to thirty days after the beginning of treatment and usually disappears in about ten days, depending on the size of the total dose. It is followed by a lessening degree of active congestion and edema. The edema may persist for several weeks or months, also depending largely on the total dose given.

Regression of the tumor may begin as early as the fourth or fifth day in lymphoepithelioma or transitional cell carcinoma, but is usually not apparent until after the first week. In the less anaplastic growths, it may not be apparent until after two weeks and may not be complete until after three or four weeks. We feel that it should be apparently complete at least by one month after beginning treatment and that although it may continue after that time, one should consider the advisability of additional treatment by the insertion of seeds if palpable or visible disease remains after one month.

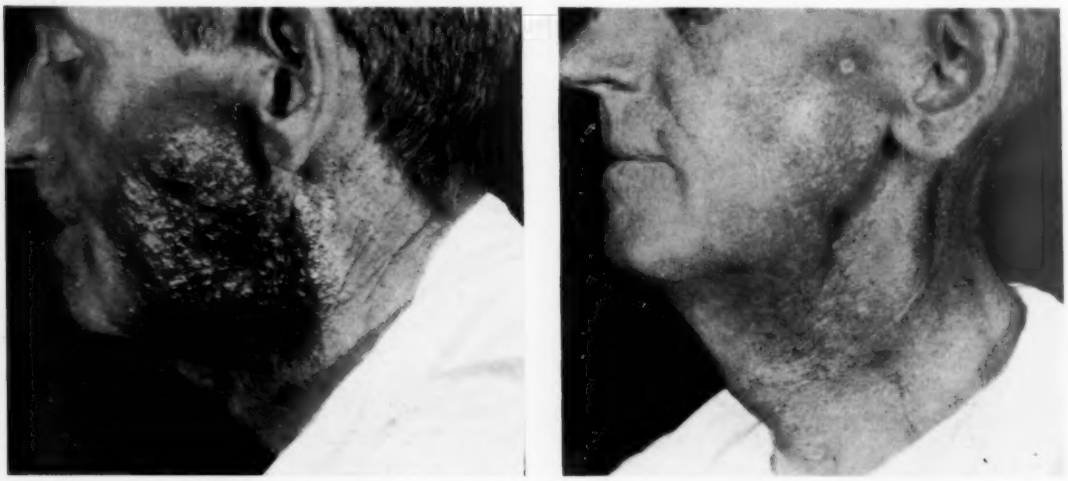


FIG. 5. Case T. K. Carcinoma of the tonsil three days after the completion of 2×3,000 r at 200 kv. over a period of twenty days, and the healed condition in about six weeks.

The skin reaction appears later than the mucosal reaction. A definite erythema of the skin is usually apparent after seven to ten days, but the skin reaction usually does not reach its height until about twenty days after the beginning of treatment, and in most cases is epidermicidal and consists of a destruction of the entire epidermis leaving a raw weeping surface which bleeds on slight trauma (Figs. 5 and 6). The skin reaction usually heals from the base or dermal layer which is not destroyed unless the reaction is very severe. In the latter case, healing may take place from the edges or from persistent islands of the dermal layer.

COMPLICATIONS

With large fields and heavy doses, the limit of the general tolerance of the patient is reached before the limit of the local tolerance. With such treatment, there is produced a chronic irradiation sickness not due to dyspnea, lack of nutrition or to changes in the skin or mucous membrane. The patient becomes listless, weak, toxic, loses weight and becomes cachectic. Such a condition is probably due to the volume of tissue irradiated rather than to the local intensity of the effect, or possibly to the partial derangement in function of the various glandular, vascular and nervous structures of the neck. Such a complication can be prevented by avoiding the use of unnecessarily large skin portals except where required by the widespread character of the disease. If large portals (200–300 sq. cm.) are used in such cases, the daily doses must be cut down to about 200 r and the total treatment period extended for seven to ten days longer.

We have not found changes in the blood picture which could be attributed directly to irradiation. Secondary anemias, though quite common, are usually found in those cases where infection has been marked before treatment and in which the untreated lesion has been the cause of dysphagia and malnutrition. Loss of weight, during and following treatment, is due to lack of sufficient alimentation and will be discussed under that heading.

Local Complications. Most patients do not complain of local pain, even at the height of the reaction, while the tongue and pharynx are at rest. In most cases there is a burning sensation both in the skin and mucosa at the site of the heaviest reaction. Any motion of the tongue and pharynx, as in the act of swallowing, is quite painful but these local symptoms seldom require the use of narcotics, even for sleep.

FIG. 6. Case G. M. Carcinoma of the base of the tongue ten days after the completion of 2×3,000 r at 200 kv. over a period of twenty days with a skin portal 10×12 cm., and the healed condition of the skin one month later.

Alteration in the Character of Intraoral Secretions. Beginning about four or five days after the first treatment, there is a progressive diminution in the quantity and an increase in the viscosity of the saliva. The patient complains of dryness of the mouth and difficulty in swallowing or expectorating these secretions. If not

relieved, the accumulation of this saliva and the serous discharge from the false membrane is the cause of a great deal of discomfort. We order, as a routine at the beginning of treatment, mouth irrigations every two hours with a 2 quart irrigating can, rubber tube and glass nozzle, using a solution of sodium bicarbonate in warm water. At night the patient is instructed to take the irrigation if he awakens and notes any marked discomfort. This simple procedure affords a marked degree of relief as is proved by the fact that it is voluntarily kept up by the majority of patients without further direction. The viscidity of the secretions is relieved in great part as soon as the mucositis clears, but dryness of the mucous membranes may persist in a lessening degree for one or two years following the treatment.

FIG. 7. Case R. B. Carcinoma of the tonsil two weeks following the completion of 80,000 mg-hr., with the radium element pack at 10 cm., and the healed condition of the skin of the neck about six weeks later.

Dysphagia is present in some degree in all cases in which a mucositis is produced in any portion of the pharynx between the soft palate and the pyriform sinuses. In most cases, soft or liquid food can be taken in sufficient quantity to maintain the admission weight. The patient should be weighed daily and be made to keep track of his own weight. If there is a loss of weight, the caloric value of the daily feeding should be calculated and forced to at least 3,000 calories. The patient of average intelligence can easily comprehend the relation between his daily weight and the caloric value of his feedings. In some cases, especially those of the hypopharynx, the dysphagia may be more marked due to a combination of pain and swelling of the arytenoids at the height of the reaction. In such patients, nasal feedings are a satisfactory solution of the feeding problem. After a few experiences, many patients welcome the nasal catheter as a simple means of obtaining a meal without discomfort.

In 3 cases, we have had to resort to gastrostomy for feeding purposes, due to late edema of the arytenoids. In all these cases, this was a late complication, one coming on six months after treatment of

a carcinoma of the hypopharynx and in another, two years after treatment of a carcinoma of the tonsil. In one case, the operation was done before beginning treatment.

Dyspnea. We have performed tracheotomy in 29 cases. Fifteen were performed either during or immediately after treatment and 14 were performed because of the late development of edema or recurrence of the disease. It is needless to discuss the indications for late tracheotomy. In uncontrolled growths of the pharynx and hypopharynx, they are commonly necessary as a palliative procedure. Late edema of the arytenoids or glottis is more common in cases free of disease in which larger rather than smaller portals were used.

Prophylactic tracheotomy should be considered in all cases of growths involving the arytenoids, ventricular folds or vocal cords. If tracheotomy becomes necessary, it had much better be done before beginning treatment, so as to avoid the necessity of opening up tissues in which there is a marked radiation reaction, and also to avoid the necessity of interrupting the sequence of treatments. Experience only can determine which cases have a fair chance of going through the period of acute reaction without marked dyspnea and the necessity for tracheotomy. If a tracheotomy is done, the skin incision should be made as short as possible and the operation done low in the suprasternal notch in order to keep as far as possible from the skin portal.

Skin Reaction. The reaction of the skin directly exposed under the beam of radiation does and should go on, in most cases, to an acute blistering or epidermicidal reaction. As Coutard has pointed out, this degree of skin effect is necessary, if one is to produce a lethal effect in the tumor by this method. The degree of skin change is alarming in appearance to observers unfamiliar with this method of treatment, but it can safely be said that such a reaction, produced by repeated treatments over a period of fifteen to thirty days, will always heal without any untoward effect. In this regard, it differs from an effect of the same apparent degree caused by one or two heavy doses, or that produced in tissues subjected to repeated treatments at long intervals.

A definite erythema is to be observed after about a week, which goes on to a deeper red, dry, sometimes pigmented appearance and then the superficial layers of the skin become raised by a layer of serum, which, being denuded, leaves a deep red weeping raw surface which bleeds quite easily. While the skin is in a dry state, we use frequent applications of mineral oil without any further dressing and where the surface becomes moist, we apply single layers of gauze bandage impregnated with boric acid ointment which is continued until healing has taken place and the skin is again dry and whole.

RESULTS

Our results for the years 1931 and 1932 are given in Table 1. Of 140 cases treated during those two years, there remain 41 cases, or 29 per cent, free of disease on September 1, 1933, for a period of from $1\frac{3}{4}$–$2\frac{1}{2}$ years. Twelve of these cases have been free of disease for a period of from 2–$2\frac{1}{2}$ years, the remainder for a period of from nine months to two years. We have not included the cases from 1933 as being too recent. Of the 19 cases treated during 1931 and now living and free of disease, 5 cases had gold seeds inserted into persistent metastatic nodes which lay either in the field of the skin portal or at sufficient distance from it so as to receive insufficient irradiation. In some of these cases, it may not have been necessary to give such supplementary irradiation, but we did not feel justified in withholding what we felt might be required to insure complete sterilization of all foci of the disease. In none of the cases, included in our report, was the primary lesion treated by supplementary means. Of the 22 cases herein reported free of disease since 1932, 5 also

TABLE I

RESULTS TO SEPTEMBER 1, 1933, FOR CASES TREATED DURING THE YEARS 1931 AND 1932

		Extrinsic larynx			Tonsil			Naso-pharynx			Pharynx and soft palate			Base of tongue			Intrinsic larynx			Anterior floor of mouth				
Years	Number of cases treated	Cases treated	Number free of disease	Per cent free of disease	Cases treated	Number free of disease	Per cent free of disease	Cases treated	Number free of disease	Per cent free of disease	Cases treated	Number free of disease	Per cent free of disease	Cases treated	Number free of disease	Per cent free of disease	Cases treated	Number free of disease	Per cent free of disease	Cases treated	Number free of disease	Per cent free of disease	Total per cent free of disease	Survival period
1931	73	31	5	16	24	9	31	9	3	33	3	0	0	4	0	0	1	1	100	1	1	100	19 cases 26%	$1\frac{3}{4}$ to $2\frac{1}{2}$ years
1932	67	22	5	22.7	17	4	23.5	12	4	33	6	3	50	6	3	50	3	2	66	1	1	100	22 cases 32.8%	9 mo. to $1\frac{3}{4}$ years
Totals	140 cases	53	10	19	41	13	31.6	21	7	33	9	3	33	10	3	30	4	3	75	2	2	100	41 cases 29%	

received supplementary treatment by radon gold seeds in persistently palpable metastases. All 5 of these cases received external irradiation only, to the primary lesion.

It is interesting to note the difference in the prognosis in male and female cases. In 1931, 73 cases were treated, of whom 9, or 12 per cent, were females. Of the 19 cases living, 4, or 21 per cent, are women. Of the males 68 in number, 15, or 23 per cent, are living and free of disease and of the 9 women, 4, or 44 per cent, are living. This relatively better prognosis in females has already been emphasized by Coutard.

The average ages of the successful and unsuccessful groups are about equal, with a slightly higher average in the successful group. This finding may be purely incidental, but it is interesting to note that the prognosis is at least as good if not better in old age. Several of our successful cases were over eighty years old on admission. The incidence of metastasis on admission, in the successful group, was about 40 per cent and in the unsuccessful 80 per cent.

In 1931, the largest successful dose was 2×3,200 r in fourteen days, in 3 cases of carcinoma of the extrinsic larynx, tonsil and nasopharynx, respectively. The smallest successful dose was 2×2,000 r in fourteen days, in one case of carcinoma of the tonsil. The average dose in the successful cases was 2×2,400 r in fourteen days. The largest dose in an unsuccessful case in 1931 was 2×2,600 r and the smallest 2×1,600 r, with several under 2×2,000 r. In 1932, the average successful dose was between 2×3,000 r and 2×3,500 r, with a few successful cases receiving more than 2×4,000 r. The average size of dose was much smaller in the unsuccessful than in the successful cases, which has emphasized to us, that with this method one is apt to err on the side of conservatism. The larger doses undoubtedly produce greater reactions and are followed by longer periods of convalescence, but they are also followed by a greater percentage of cures.

A consideration of Table 1 will reveal that the prognoses in the various anatomical groups are in the following order: tonsil, 31.6 per cent; nasopharynx, 33 per cent; pharynx, 25 per cent and extrinsic larynx, 19 per cent. The numbers treated in the various other anatomical groups are too small to permit decisive conclusions.

The prognosis in the general group of pharyngeal tumors is influenced less than one would expect by the histological type. In the 140 cases included in this report, about 60 per cent were classified as adult or differentiated histologically and therefore radioresistant (squamous or epider-

moid carcinoma, Grades I and II). The remainder, or 40 per cent, were classified as anaplastic or undifferentiated and therefore radiosensitive (lympho-epithelioma, transitional cell carcinoma, epidermoid carcinoma, Grades III and IV, and lymphosarcoma). The same percentage distribution is not found in the successful and unsuccessful groups. In the unsuccessful group of cases (99 in number) 75 per cent are found to be of the adult or differentiated (radioresistant) variety and 25 per cent in the anaplastic or radiosensitive. In the successful group (41 cases) 55 per cent are adult or differentiated and 45 per cent anaplastic. This difference in percentage distribution indicates a moderately better prognosis in the radiosensitive group. On the basis of radiosensitivity alone, there should be an even greater difference in prognosis, which is balanced, in part, by the tendency to early and widespread metastases in the anaplastic and more highly malignant tumors, although the local response to irradiation may be comparatively rapid and complete.

Practically all the unsuccessful cases died of persistent cancer either local or metastatic. Several locally successful cases have died of visceral metastases. In a majority, the treatment undoubtedly lengthened life, but in a few there seemed to be very little palliation. A few of our cases undoubtedly died chiefly from the effects of treatment where large portals and massive doses were used.

It would be of great interest and practical value, if one could definitely state the cause of failure in all the unsuccessful cases. The histological findings, in many instances, give no clue. What seems to be a fairly radioresistant tumor, histologically, may regress rapidly and completely and lympho-epithelioma or transitional cell carcinoma may prove resistant to the heaviest doses. Those cases which metastasize widely, often beyond the neck, are doomed to failure from the beginning. Some of our failures were due to errors in the direction of the beam.

The divided dose method may be used to advantage in any form of radiation therapy, and at the present time we are employing it in a large percentage of cases where a combination of external and interstitial irradiation is planned from the beginning. According to this plan, instead of giving two or three massive doses of external irradiation followed by interstitial irradiation, we give multiple daily doses over a period of two or three weeks, followed immediately by implantation of gold radon seeds. By this combination of methods, a large bulky tumor may be reduced to one-half or one-fourth of its original size, thereby greatly reducing the necessary dose of radon implants. We have a number of successful cases treated by this method which are not included in this discussion.

SUMMARY

A technique for the treatment of cancer of the pharynx, tonsil and extrinsic larynx by divided doses of external irradiation is described in detail. The results in 140 cases treated by this method during the years 1931 and 1932 are reported.

REFERENCES

1. COUTARD, H. Roentgen therapy of epitheliomas of the tonsillar region, hypopharynx and larynx from 1920 to 1926. AM. J. ROENTGENOL. & RAD. THERAPY, 1932, *28*, 313–331.
2. LENZ, M. Roentgenotherapy of malignant neoplasms of the pharynx and larynx. *J. Am. M. Ass.*, 1932, *99*, 1840–1845.
3. HARRISON, J. STEWART. Malignant disease of the larynx and pharynx. *J. Laryng. & Otol.*, 1932, *47*, 725–755.
4. ZUPPINGER, A. Resultate der protrahiert-fraktionierten Röntgentherapie von malignen Tumoren. *Strahlentherapie*, 1932, *43*, 701–718.
5. FAILLA, A., and QUIMBY, E. H. Economics of dosimetry in radiotherapy. AM. J. ROENTGENOL. & RAD. THERAPY, 1923, *10*, 944–967.
6. BERVEN, E. G. E. Development of technique and results of treatment of tumors of the oral and nasal cavities. AM. J. ROENTGENOL. & RAD. THERAPY, 1932, *28*, 332–348.

RADIUM DOSAGE AND TECHNIQUE IN CARCINOMA OF THE BREAST*

By GRANTLEY W. TAYLOR, M.D., F.A.C.S.
BOSTON, MASSACHUSETTS

INTEREST in the radium treatment of carcinoma of the breast at the Pondville Hospital was stimulated by the report of Geoffrey Keynes of St. Bartholomew's Hospital, London, describing his technique of interstitial radium treatment, published in the *Lancet* in 1928.[1] This interest was fortified by the enthusiastic report of a member of our staff who visited Keynes' clinic the following year. Accordingly, some of our radium was made up in the form of platinum needles, and we began to treat selected cases of carcinoma of the breast with them in October, 1930. This report will concern itself with the experience of the Pondville Hospital, along with a certain number of private cases treated at the Palmer Memorial Hospital.[2] It is obvious that respecting a method of treatment so recently adopted, technique is experimental, indications are tentative, and conclusions are premature.

INDICATIONS FOR RADIUM TREATMENT

Our treatment of choice for operable carinoma of the breast is radical surgery. In the treatment of inoperable and recurrent cases our chief dependence has been on roentgen therapy. Analysis of the cases actually treated with radium establishes the fact that in the majority of cases the disease has been inoperable, either by virtue of its local extent or the presence of remote metastases. At the same time, the primary growth has been superficial enough or localized enough to call for a more intensive concentrated irradiation than that which can be achieved by roentgen therapy alone. The primary growth has usually been movable on the chest wall, but often so extensive as to involve most of the breast, occasionally presenting nodules of skin involvement or ulceration. Axillary metastases have been present in most cases, and in many there has been supraclavicular node involvement. A few of the cases were potentially operable as regards the local lesion, but operation was contraindicated by the poor general condition of the patient or by the presence of remote metastases. A small number of cases were treated for localized recurrences after operation. Thus, in the main, radium treatment was essentially palliative, and was used as part of a general plan of radiation therapy, most of which was delivered in the form of roentgen rays. In a few instances palliative surgery was combined with radium therapy, either simultaneously or subsequently.

Local ulceration of the tumor was not considered to be a contraindication to radium treatment. Simple antiseptic dressings were maintained on ulcerated areas during the patient's stay in the hospital. At the time of radium insertion the skin was prepared in the usual way, and care was taken to prevent contamination of the puncture wounds by secretions from the ulcer. In one case with a very extensive foul sloughing tumor, the bulk of the local growth was removed with electrosurgery before the radium was inserted.

EFFECT ON ADJACENT NORMAL STRUCTURES

There has been practically no serious injury to adjacent normal structures. Some of the patients have had pain in the chest

[1] Keynes, G. Radium treatment of primary carcinoma of breast. *Lancet*, 1928, *2*, 108–111.

[2] I am indebted to Dr. Charles C. Lund of Boston for permission to include 6 of his private cases in this study. The group is made up as follows: 24 primary and 4 recurrent cases treated at the Pondville Hospital; 12 primary cases treated at the Palmer Memorial Hospital.

* From the Pondville Hospital, Massachusetts Department of Public Health. Read at the Nineteenth Annual Meeting, American Radium Society, Cleveland, Ohio, June 11–12, 1934.

or arm which might have been due either to radium or to the disease itself. In no case has this been so definitely associated with the radium treatment as to justify the assumption of radium injury. One patient who had received considerable roentgen therapy prior to the radium treatment showed on roentgen examination a year later a condition interpreted as possible fibrosis of the lung.

The skin of the breast and axillary area invariably suffers some injury. The changes range from an erythema to ulceration or even widespread necrosis. Some of the ulcerations became chronic, and in a few instances have been dealt with by surgical excision or simple mastectomy. Surgical wounds in these irradiated areas are often very sluggish and seem to be particularly liable to infection. Some patients have had recurrent erysipeloid infections apparently originating in minor fissures and abrasions.

It is impossible in most cases to decide whether the radium or the roentgen ray is responsible for the damage observed. There does not seem to be any close correlation between the dose employed and the amount of damage observed.

TECHNIQUE

The needles used contain 2 or 3 milligrams of radium, with 0.5 mm. platinum filtration. The 2 mg. needles are 3.2 cm. long, and the 3 mg. needles are 4.8 cm. long. They are pointed at one end, and have an eye which is threaded with heavy silk at the other end.

The breast and axilla are prepared as for a surgical operation. Nitrous oxide and oxygen anesthesia is ordinarily used. The field is prepared with tincture of metaphen or some other skin antiseptic. If tincture of iodine is used it should be washed off with alcohol before implantation of the needles. Punctures are made through the the skin with a small pointed knife (No. 11 Bard-Parker blade). The needles are inserted and thrust full length into the tissues. When the skin has been punctured very little force is required to insert the needles. The arrangement and distribution of the needles is largely determined by the size and position of the lesion and the size of the breast. When the breast is relatively small, and the growth is central, a radiating arrangement of the needles is satisfactory. They are inserted at the periphery of the breast tissue, and passed centrally between the breast and the pectoral fascia. It is well to avoid insertion into fibrous breast tissue, or into solid carcinoma, if possible, as needles so inserted seem to cause more discomfort to the patient, and it is sometimes difficult to extract them. When the patient is obese, the breast large, and the lesion small or superficial, sometimes it is not feasible to irradiate the entire breast intensively, and a concentrated arrangement of needles is preferable, directed primarily at the tumor mass. These are often best arranged in parallel lines, or in gridiron form. In these cases it is sometimes necessary to plant needles into the breast tissue or even into the growth itself. We observed one instance of implants of cancerous nodules in relation to the skin punctures in such a case. Keynes, in his paper, recommended that the needles be placed about 1.5 cm. apart, but his pictured distributions indicated considerable latitude in arrangement and concentration. As a rule, we have not planted our needles so close together as this, and find that about a dozen needles are enough for radial distribution in all but the large breasts.

The axilla should be irradiated in a similar way. In small patients an attempt should be made to irradiate the whole axilla; in obese patients, with large palpable nodes, it is often more effective to concentrate the needles in the vicinity of the metastases. A satisfactory distribution for axillary irradiation is arrangement of the needles in a conical or pyramidal pattern, with the apex at the apex of the axilla. It should be remembered that if these needles are planted with the arm in abduction there may be considerable change in position of the needles when the

arm is brought to the side. Often the needles at the time of removal may be found very deeply imbedded, due to motions of the arm during the course of the treatment. The apex of the axilla is effectively irradiated by needles implanted in the infraclavicular region. We have been a little cautious about supraclavicular insertion, and have restricted it chiefly to cases in which nodes were demonstrably enlarged. In some cases we have made incisions in this region to permit accurate placement of the needles in relation to the nodes. We have not inserted needles in the anterior mediastinum through the intercostal spaces as advocated by Keynes.

The silk threads are assembled in convenient groups and fastened with adhesive plaster. The needle count is checked and a diagram is made of the distribution. Sterile dressings are then applied and held in place with a swathe, and the arm is brought to the side where it is held with another swathe. As a rule, the patients are fairly comfortable during the treatment and medication is not often necessary Motions of the arm sometimes cause pain. Nausea has been observed in some of the patients, possibly as a result of the irradiation.

The duration of the treatment, as a rule, is a week although it may be varied from a few days to ten or more, depending on the number of needles used, the size of the growth and so on. In several of the Pondville cases, because of the limited number of needles, we have reinserted the needles in another area for a second week. Extraction of the needles can usually be carried out without anesthesia, although occasionally some difficulty may be encountered.

DOSAGE

When patients are treated in this way, the dose per needle ranges from about 300 mg-hr. for 2 mg. needles, to about 500 mg-hr. for the 3 mg. needles, or even to 700 mg-hr. if the needles are left in place for ten days. Thus a total dose varies from about 5,000 mg-hr. to about 20,000 mg-hr., depending on the number of needles used and the duration of application. Repetition of treatment is not usual. It is determined by the dose of the first treatment, evidence of persistent activity of the growth, increase of involvement of regional lymph nodes, the amount of roentgen treatment given, and the condition of the skin.

BIOPSY

Keynes[3] originally insisted on a biopsy in all of his cases, securing a specimen at the time of extraction of the needles. Later he warned against the possibility of implantation of carcinoma in the biopsy wound, and contented himself with a clinical diagnosis of carcinoma in many instances. We have secured biopsies in our series when it was possible to do so, but are reluctant to cut into a deeply placed lesion. The Hoffman punch commends itself for trial, but has not been very satisfactory in our hands. We have been less insistent on biopsy because in most of our cases the diagnosis was clinically obvious, and palliation rather than cure was the aim of treatment. If the radium treatment of breast cancer is to be undertaken for operable cases with attempt at cure, biopsy, although hazardous, must be insisted upon. Likewise, if cures are to be reported, the five year follow-up period must be reckoned not from the date of the first treatment, but from the date of the last treatment. One case in this series, typically inflammatory carcinoma clinically, proved to have a gumma on pathological examination. The radium treatment did her no harm, but without the pathological examination she might readily have been considered a cured case of carcinoma. In another instance, not in this series, simple mastectomy was carried out for a persistent mass after radium treatment. The pathologist found a cyst of the breast, and no carcinoma.

[3] Keynes, G. Radium treatment of carcinoma of breast. *Brit. J. Surg.*, 1932, *19*, 415–480.

ROENTGEN THERAPY

Most of the patients treated with radium also received intensive roentgen therapy. In about half of the cases some roentgen treatment preceded the radium treatment. About 300 r was given at a treatment for a total of 1,200 r in a series. Many patients received several series of treatments. Most of the cases received roentgen irradiation after the radium treatment. In young patients before the menopause we now carry out roentgen sterilization almost as a routine, and this has been carried out on several patients in this series.

RESULTS

It is obvious that it is premature to report results, except for the immediate response to treatment. It should be borne in mind that our results cannot be compared directly with Keynes', for the following reasons: (1) our technique differed considerably from Keynes'; (2) we used a great deal of roentgen therapy along with the radium; (3) our aim was primarily palliation.

Of the 40 cases studied in detail for this report, 19 are dead. Two of these had very favorable regressions of the lesion and died of other causes five months and two years respectively after radium treatment. One lesion proved on pathological examination to be a gumma rather than carcinoma. Of the 20 remaining cases, 8 were treated within six months, and are too recent to permit judgment of the effect of treatment. Of the remaining 12 cases, 1 patient was subjected to radical operation six months after the radium treatment, and now shows no evidence of disease one year after operation. The remaining 11 cases all present evidence of uncontrolled metastatic disease, 9 in the axillary and supraclavicular areas and 4 in the skeletal system.

As regards the immediate effect of the radium treatment, 37 of the cases showed regression of the primary breast lesion, and this has been apparently a permanent arrest in 24 cases. Three cases showed no regression of the local process after radium treatment and died rather rapidly. It is noteworthy that when specimens for pathological examination have been obtained from these breasts which apparently show no active malignancy, the specimen in all but one case has shown microscopic evidence of cancer.

Axillary metastases showed regression after radium treatment in 14 cases. This was rarely so complete or so lasting as it was in the case of the primary breast lesions. In only 5 cases was regression observed in nodes in the supraclavicular region. No effect was observed on the propensity to develop remote metastases. One patient in whom there was apparent clinical arrest of the disease in the breast for one year after radium treatment was submitted to radical operation. This was followed by the development of widespread remote metastases and death within six months after operation. Another case similarly treated is living without evidence of disease one year after operation. If a carcinoma is inoperable at the time of radium treatment, it does not seem reasonable to hope that it may be rendered operable by radium treatment. Indeed, it seems as if subsequent operation might break down barriers to the dissemination of disease which were set up by the radium treatment.

Six patients developed chronic ulcerations which seemed reasonably attributable to the radiation which they had received. In one instance simple mastectomy was carried out to get rid of the ulceration. The pathologist was unable to find carcinoma in this specimen, although the patient has definite lymph node involvement in both supraclavicular regions.

SUMMARY

Interstitial radium treatment in selected cases of inoperable carcinoma of the breast has been used at the Pondville Hospital for about four years.

Keynes' platinum needles have been employed with doses ranging from 5,000 to

20,000 mg-hr. Roentgen treatment has been given in addition to radium in most cases.

Regression of the local process was secured by treatment in almost all cases, and seemed to be better than that which could be secured with roentgen treatment alone.

CONCLUSIONS

Radium implantation causes regression of the primary tumor of carcinoma of the breast in most instances.

Radium implantation causes regression of axillary metastases in many cases, and of supraclavicular metastases in some cases.

Regressions appear to be arrest rather than eradication of disease in most instances.

Radium implantation is a useful palliative treatment for inoperable carcinoma of the breast when it is used as part of a general program of irradiation.

We do not feel that there is justification for treating operable cases with radium unless operation is definitely contraindicated by the condition of the patient.

DISCUSSION

Dr. George E. Pfahler, Philadelphia. The subject of the implantation of radium needles brought up by Dr. Taylor is always interesting, and I am convinced that we have in this method described by Keynes very definitely advanced in the treatment of cancer of the breast. I believe, however, that we should not depend upon the insertion of these radium needles but that we should combine skillfully, and according to indications in each case, high voltage radiation therapy externally.

Dr. Taylor (closing). I agree with what Dr. Pfahler said about radium irradiation of the breast being just a part of the treatment. We feel that it is a very valuable aid in the treatment of breast conditions which are not primarily operable.

Vol. XXXII, No. 6

RADIUM DOSAGE AND TECHNIQUE IN BENIGN LESIONS OF THE SKIN*

By HOWARD MORROW, M.D., *and*
LAURENCE R. TAUSSIG, M.D.
SAN FRANCISCO, CALIFORNIA

DURING the past thirty-five years radium has found an important place in the therapy of dermatological conditions. In the earlier enthusiasm that developed following the discovery of radium, it was used in a large number of skin conditions in the expectation and hope that a universal panacea had been found. Experience has shown that the use of radium has important limitations. The greatest of these is the danger of late sequelae: telangiectasia, atrophy, keratoses and even malignancy. The possibility of these undesirable and even dangerous sequelae is particularly important in dealing with benign conditions. It is manifestly improper to make use of a form of therapy for a benign lesion which may cause a condition worse than that for which the patient is treated. Late sequelae can be guarded against by limiting the dosage to that which does not cause the development of an erythema. It is true that sequelae do occasionally appear following a large number of suberythema doses of radiation and there is no exact criterion of the amount of radiation which may be given with safety.

A further limitation of radium therapy is found in the development of modern roentgen therapy in dermatology. The improvement that has occurred both in the matter of equipment and technique in roentgen therapy has done much to limit the field of usefulness of radium. There are but few conditions responding to radiation in which the roentgen ray is not at least equal to radium. In the treatment of benign conditions of the skin the superiority of roentgen radiation over radium radiation is particularly notable. In the earlier enthusiasm, radium was used in the treatment of psoriasis, lichen planus, eczema and a number of other benign conditions. No one would think of using radium for the treatment of any of these at the present time. In the following outline only those conditions will be discussed in which radium is generally considered superior or equal to the roentgen ray and other forms of therapy.

CONGENITAL ANOMALIES

1. *Vascular nevi* occur in three forms: nevus flammeus, nevus vasculosus and cavernous angioma.

(a) *Nevus flammeus* (port wine mark) is a pink to blue red area varying in size from that of a finger nail or smaller to that of the palm of a hand or larger. It is not raised above the level of the surrounding normal skin and usually appears at or shortly after birth. The light pink lesions of this type that occur frequently on the nape of the neck tend to disappear spontaneously in a few months or years after birth. Treatment of nevus flammeus is usually very unsatisfactory. Some authors have reported good results from the use of small doses of beta radiation. Our results have been disappointing and we now decline to treat them.

(b) *Nevus vasculosus* (strawberry mark) is a slightly raised, bright red to blue red lesion which may be smooth or verrucous and it may be raised from less than a millimeter to 2 or 3 mm. above the surface of the surrounding skin. This type of nevus is particularly susceptible to treatment. Radium radiation and carbon dioxide snow treatment produce satisfactory results. As a result of either form of therapy a certain

* From the Department of Medicine, Division of Dermatology of the University of California Medical School, San Francisco. Read at the Nineteenth Annual Meeting, American Radium Society, Cleveland, Ohio, June 11–12, 1934.

amount of scarring occurs, but in favorable cases neither method causes an unpleasant scar. The chief advantage of radium therapy is the lack of pain or reaction, both of which are considerable when carbon dioxide snow is used. The great disadvantage of radium therapy is the long period of time necessary to produce the desired result. It often requires from one to two years to obtain the maximum improvement. Radium may be applied to these lesions either in the form of a "glazed plaque" or in tubes of the element or of radon. If a plaque is used a filter of 0.3 mm. of brass plus a layer of dental rubber dam is interposed between the active surface and the lesion. The normal skin surrounding the lesion is screened with lead foil. With a half strength plaque an exposure of one hour is given at two to three month intervals for as many as five or six treatments if necessary. In most instances two or three treatments suffice. If tubes are used they should be so arranged that one tube is applied for each square centimeter of surface. Twenty milligram- or millicurie-hours is given with each tube using a filter of 0.5 mm. of silver and 1 mm. of rubber.

(c) *Cavernous hemangiomas* vary in size from that of a pea to that of a tennis ball or larger. They may be diffuse or circumscribed and are often surmounted by a nevus vasculosus. In the treatment of most of the lesions of this type radium is the treatment of choice. Carbon dioxide snow in sufficient dosage to effect a cure causes undue scarring except in the very small lesions. Surface radiation in dosage similar to that used for nevus vasculosus may be of considerable value, especially as it is often possible to make use of the principle of cross fire radiation and multiple points of entry. The larger lesions, however, require an amount of radiation which would cause an undesired amount of atrophy. This may be avoided either by increasing the filter to 0.5 mm. of brass or by the use of interstitial radiation. This is conveniently accomplished by the insertion of gold seeds of radon. These seeds have a wall thickness of 0.3 mm. and contain from 1.0 to 1.5 mc. of radon. The number of seeds used varies with the size of the lesion, usually four or five are sufficient for even a very large angioma. It is better to lean toward an insufficient dose as the treatment may be repeated if necessary. The procedure is only momentarily painful, there is no reaction and no unpleasant sequelae have been noted.

2. *Fleshy nevi* occur in a number of forms. They may be pigmented, hairy, warty, etc. These lesions have been treated in the past by radiation but experience has shown that the amount of radiation necessary to destroy them was necessarily sufficient to cause destructive changes and dangerous post-irradiation effects. None of them should be treated by radiation.

ACQUIRED CONDITIONS

1. *Keloids* or hypertrophic scars may follow any type of traumatic injury in a susceptible individual. They are most common in negroes and individuals with dark complexions and are particularly apt to develop following injuries that are slow in healing due to secondary infection. The differentiation between a true keloid and a hypertrophic scar is often a matter of personal opinion but the treatment in either case is the same. Radiation therapy either alone or in combination with plastic surgery is the treatment of choice. Roentgen radiation is equal in its effect on these lesions to radium radiation and is usually to be preferred, especially in extensive lesions. Radium may be used with satisfactory results in smaller lesions, particularly when they are linear. Radon tubes are usually applied filtered with 0.5 mm. of silver and 1.0 mm. of rubber. The dose given is 20 millicurie-hours for each tube used. This may be repeated at two or three month intervals for five or six treatments if necessary. The scar following successful radiation therapy is soft, smooth and white. Telangiectasia is rather commonly seen in keloids and may remain in the resulting scar.

2. *Verrucae* of all types are frequently treated with radiation. Most of them are better treated by other means. From 80 to 90 per cent of plantar warts are amenable to a single intensive dose of radiation and these are the only verrucae that should be irradiated routinely. Roentgen rays and radium are equally efficacious in the treatment of these lesions. On account of the economy of time roentgen irradiation is preferable. If radium is used, a small double strength glazed plaque containing 5 milligrams of radium element is most satisfactory. The filter used is 0.1 mm. of aluminum plus a single layer of dental rubber dam. An exposure of one hour is usually sufficient. The plaque is small enough so that no screen of the normal tissues is required. It is to be noted that if a single dose of radiation does not cure the lesion other forms of treatment should be made use of. Other warts are only occasionally suitable for radiation therapy. Among these are the ones occurring under and close to the finger nails. Roentgen radiation is most frequently used but occasionally the small plaque used for plantar warts is suitable. If this is used, not more than one-half the dose used for plantar warts is applied and this should not be repeated.

3. *Synovial cysts* occur at the joints usually in individuals showing evidence of a hypertrophic arthritis. They contain a clear jelly-like substance and are usually painless. They may be emptied by incising with a pointed knife and sometimes a single exposure of radiation will prevent their recurrence. Moderate beta radiation or unscreened roentgen radiation is used. Probably less than half of them respond to irradiation and the roentgen ray is just as effective as radium. If radium is used the double strength, 5 milligram plaque, filtered with 0.3 mm. of brass applied for one hour, is a suitable dose. If a tube is used it is screened with 0.5 mm. of silver and 1 mm. of rubber and a dose of 30 mc-hr. given with the normal skin carefully screened with lead.

4. *Epulis* is usually most satisfactorily treated by electrothermic surgical methods rather than by irradiation. The vascular type which may occur between the teeth is an exception. The treatment of these by electrodesiccation may cause the loss of one or both teeth. For them radiation in the form of a radium plaque moderately filtered may prove curative. The dosage and method of application vary with the characteristics of each growth.

CONCLUSIONS

1. In most benign dermatological conditions in which radiation therapy is indicated, roentgen rays are superior to radium.

2. The notable exceptions are the vascular birth marks. In the cavernous hemangiomas radium is by far the best method of treatment while in nevus vasculosus it has certain important points of superiority over any other form of treatment.

DISCUSSION

Dr. W. S. Newcomet, Philadelphia. I am going to discuss this paper entirely from the standpoint of the radiologist. In all the essential points throughout, both in the use of roentgen rays and radium, I agree. Especially in treating benign tumors one must be careful to substantiate the stand he takes. Before radiation of any kind is used all other forms of treatment should be fully considered. Dr. Morrow spoke of the sequelae. In children especially we must be doubly careful. If we carry treatment for hemangioma too far, when the patients mature we may find that the results are not so good; not only from scarring and telangiectasis but a decided atrophy of the part. I have a few lantern slides that I would like to show you because they bear on this question. (Presented lantern slides.)

In regard to radiation treatment of port wine stains, I have always felt that we are likely to cause considerably more trouble than good for they go deeper into the tissues than is usually supposed and the poor results in these cases are not due to the superficial character of the lesions, but they go deep and contain a greater proportion of fibrous tissues than the cavernous type. Where there is fibrous or lymphoid tissue

in these tumors the results are not nearly so good as when there is only an inflammatory lesion.

I am not in favor of putting seeds in benign growths and think we can treat most of the cases without the insertion of foreign bodies. In the pigmented nevi it is advisable to try a suberythema dose of radiation and see what can be accomplished, but excessive irradiation is dangerous. I agree that the deeply pigmented nevi will not respond.

Dr. Morrow said that in small keloids radium can be employed but in large ones its use is almost impossible. If one has enough radium so that a uniform dosage can be given over the area, and can carry these cases along for the necessary time the results will be very good.

I have seen several cases in which women have developed a small keloid on the breast; they appear suddenly from no assignable cause; a number of them have been painful. Their position is directly over the upper third of the sternum, and they are about 1 or 1½ inches in length and about ½ inch in width. They usually respond well to irradiation.

DR. GEORGE E. PFAHLER, Philadelphia. I agree with all the speakers have said. I have not had satisfactory results in the treatment of port wine stains with radium, and would like to have Dr. Morrow tell us in closing just what we should do with those.

I think we must be very careful about using either radium or roentgen rays in growing extremities. I have had my best results with electrothermic desiccation carefully done and then following in about three weeks with skin grafts.

DR. FRANK E. SIMPSON, Chicago. I agree in a general way with Dr. Newcomet. I do not like to use seeds in keloids for we do not get good results by this method. I do use this method sometimes in hemangiomas of the tongue where the cosmetic results are not so important. In the subcutaneous hemangiomas I think it is best to apply 1,000 mc. at a distance of 6 or more centimeters and treat them by what we call "distance" irradiation or the radium "bomb" method. In this way, large subcutaneous hemangiomas may subside without any skin reaction whatever.

DR. MAURICE LENZ, New York City. I would like to know whether Dr. Morrow has had any experience with bone changes in the treatment of hemangiomas in babies under six months of age. I have in mind a case in which I am at a loss to know whether the atrophy of the bones of the hands was due to the irradiation or to the hemangioma. I treated the child for a large hemangioma of the palm and two or three months later there was marked atrophy of the hands. Did I arrest the development of the bone by the radium therapy, or did the hemangioma cause the atrophy of the bones?

DR. H. H. BOWING, Rochester, Minn. In addition to the case reported by Dr. Lenz, may I mention the case of a female baby who, when less than three months of age, had a diffuse subcutaneous hemangioma of the lower extremity extending from the knee to well below the ankle. The part involved formed a cylindrical enlargement of the lower leg. The area of involvement was marked off in multiple fields which measured about 3 by 4 cm. The radium was heavily filtered and placed at a distance of 2.5 cm. from the surface. Two or four fields were treated at a time and, as I recall, about 75 per cent of an erythema dose was given to each field.

The patient is now about thirteen years of age and the entire leg is symmetrically shortened. The roentgen findings are negative. The reduction has been very gradual, and it is impossible to state whether further shortening will occur. With an untreated, extensive, unilateral hemangioma involving an extremity we have also observed lengthening of the leg, perhaps on account of the increased blood supply to the part. We all appreciate that the epiphysis in children may be sensitive to irradiation and, when we treat these patients, we should remember that we are perhaps causing some change that will show up as the years go by.

DR. EDWARD H. SKINNER, Kansas City, Mo. This matter of asymmetry following radiation therapy has interested me. Certain German reports have appeared of asymmetry of the breast following treatment of tumors of the breast at the time of puberty. One patient had reached the age of twenty and exhibited asymmetry which she felt was due to interference in the development by the roentgen therapy. I am convinced that this is possible, and always attempt to have such patients wait, if possible, until growth has been almost completed. In the treatment of hemangiomas and hygromas we should wait until the children have developed all the sinuses.

DR. MORROW (closing). We have not had any

of these children with bony changes in the hands, and all I know about them is what I have seen in the literature.

I was glad to have Dr. Newcomet show the slide of the idiopathic keloid of the chest. I think this particular type, which is very common, responds better to irradiation than the usual type. We are in the habit of calling this the dumbbell type.

Answering Dr. Pfahler, we said in the paper that we advised our patients not to have treatment for angioma simplex. That is true. We advise all the patients we have with an extensive lesion of this type to use a preparation containing zinc oxide which will cover the lesion somewhat. In the lesions that are so small that you can see the capillaries, we frequently destroy those by touching the point of the cautery to a small dilated capillary, with the point heated just below red heat. The patient can stand that without novocaine and it must be done without an anesthetic, for if the skin is anesthetized we cannot see the fine individual capillaries.

THE CARE AND TREATMENT OF CHRONIC CANCER CASES

By IRA I. KAPLAN, M.D.
Director, Division of Cancer, Department of Hospitals
NEW YORK CITY

CHRONIC cancer cases may be divided into two large groups:

(1) Those for whom something radical can be done in the form of intensive treatment, and

(2) Those for whom only such measures can be undertaken as will relieve mechanical or functional disturbances of normal body condition.

Chronic cases may also be divided into (*a*) those which may be treated ambulatory; (*b*) in the home; and (*c*) only in the hospital.

The ambulatory cases may be those undergoing active therapy or merely being observed in the routine follow-up clinic. They represent cases with arrested malignant conditions, or those in which recurrences of moderate character have taken place, requiring active treatment, and those cases requiring periodic treatment in order to control a quiescent lesion.

The patients for home care are those who may have (1) an arrested cancer condition, but who are too weak or too aged to come to the clinic for observation or treatment; (2) patients who are too far advanced in the course of their disease for any treatment to be done and who refuse, or whose family would not permit, hospitalization and (3) those cases whose condition may be more or less arrested and whose economic condition permits only occasional visits to the clinic.

The home care of cancer patients is an important factor in a Cancer Service and is best carried out through the Social Service Division, for they not only take care of the medical and economic aspects of the patient's condition but provide as well for his family's welfare. Of prime importance is the fact that this Social Service home care for cancer patients relieves a busy cancer hospital of the necessity of keeping its beds filled with patients who actually do not require hospitalization for any long period of time, and thus makes room for other patients to be treated. In addition, it makes it possible for patients to live out the balance of their lives at home without subjecting their families to any danger or inconvenience.

The third group of chronic cancer cases must be cared for in the hospital. They may be divided into two divisions: (1) those with an arrested malignant condition who are aged and the malignancy is of slow growth, causing no symptoms or interference with normal body function, or with slow-growing malignancies that are quite superficial and symptomless and (2) those chronic cases where the malignancy is advancing slowly but destroys surrounding tissues and organs, causing symptoms, more or less, which are intense enough to confine the patient to bed or to require hospital care.

For the first group a custodial home is necessary. Hospitalization is not required and to all intents and purposes these patients can live out their days in comparative comfort regardless of the malignant lesions. Such are the cases of old women who have had nodular scirrhous breast tumors existent for years and which, in most instances, have been found only in the course of routine examinations for other conditions. No surgical treatment is advisable for such old people nor is irradiation either feasible or effective. Old keratotic, hard, fixed, slow-growing basal cell epithelioma of the skin may well be left alone, for its growth is so slow that the patient can bear it and live comfortably, nevertheless. Another group of aged pa-

tients, after they have reached the age of three score and ten, manifest symptoms of malignancy, such as bleeding from the cervix or uterus, or ulcerations of small extent in the mouth, nose, skin or rectum. For these topical applications of radium will heal the local lesions and the patients can continue up and about with but little effort and live until death ensues from ordinary old age causes. This type of old age patients, even though they have cancer, do not have to be kept in a cancer hospital where beds are needed for more active cases requiring medical attention, but are best cared for in homes for the aged.

Chronic patients with active cancer lesions require irradiation at various periods in the course of their disease, and since this form of therapy is best carried out in a central institution where facilities for this costly form of treatment are available, they must be hospitalized.

In some cases surgical intervention may be required. In these cases, while the malignant lesion may be considerably advanced so as to be beyond radical surgical treatment, and is no longer operable, quite frequently a great deal may be done in the way of coördinated surgery and irradiation, to eradicate or destroy the local condition and inhibit further growth of secondary lesions. In many such instances, the surgery required is supplementary to radiation therapy measures. Sometimes, too, the surgical procedure is of a minor character and may be carried out in the radiation department. In chronic cases, when intensive irradiation is necessary, hospitalization is required during the active period because of the general effect of such intensive treatment on the health conditions of the patient.

In many chronic cancer cases, the malignant lesion may cause mechanical obstruction or interference with the normal functioning of the body. The urgent need for relief of these symptoms is paramount and supersedes consideration of the generalized disease. We have often seen hopeless cancer cases materially relieved and the severity of their symptoms mitigated by measures to remove obstructions and restore to proper function the other organs of the body. In many instances, after these mechanical reconstructions have been effected, nothing further can be done in the way of active treatment and such patients no longer need hospitalization. These people will be better off, mentally and physically, if they are cared for at home or in convalescent institutions.

As examples of this group may be cited extensively involved rectal carcinoma cases. In such types, the mechanical relief of the obstruction by colostomy is all that can be done to alleviate the condition. Hygienic care of the artificial anus, and general body hygiene and development of strength is all that can be prescribed following the operative procedure in many of these cases. This can well be accomplished in the home, provided economic provision is made for the necessary supplies and dressings incident to such a condition.

Patients with postoperative metastasis from cancer of the breast, in many instances, can be cared for without hospitalization. Such patients may have the comfort of family contacts at the same time receiving active radiation therapy, if transportation costs are provided for through charitable sources. Likewise, in cases of carcinoma of the larynx, following irradiation where tracheotomy has already been done and only hygienic care is necessary, patients need not be hospitalized, but may be cared for at home by visiting nurses or occasional visits to the clinic.

In cases of gastric and esophageal cancer, little can be done except to provide a method of artificial feeding. After this has been accomplished, and the patient taught how to feed himself, hospitalization is quite unnecessary in a great many instances. Home care by the family, supervised by an efficient Social Service nurse, is sufficient to carry such patients along for an extended period.

Hospitalization is therefore needed in chronic cases only when these cases are undergoing: (1) active surgical treatment; (2) active intense irradiation; (3) palliative medication at periodic intervals; (4) continued treatment, and because of the persistence of and continuous growth of the disease, requiring expert nursing and medical care; (5) surgical or medical treatment subsequent to intensive irradiation.

All other types of chronic cases can be cared for either in a home for the aged, a custodial institution, or among their families in their own homes. In the last named, care at home may be supplemented by periodic visits of the home nurse or social service assistant attached to the cancer hospital.

Unfortunately, the present cancer hospital at Welfare Island is not large enough to care for all those active chronic cancer cases which at present crowd the wards of the general hospitals caring for acute cases, and moreover, because of the odious association with custodial institutions on the Island, it is not acceptable to all patients. Furthermore, its beds are filled, in large measure, with aged sick whose cancer lesions are of little significance in their lives and who, because their lesions are slow-growing and neither contagious nor infectious, could readily be cared for in an old people's home or similar institution.

So much real good can be accomplished in many instances in cancer cases—according to Forssell at least 44 per cent of all cancer cases are amenable to a coördinated surgical and radiation therapy—that it seems a pity the cancer hospital is not assisted in carrying out this service, because it must, under present circumstances, house indiscriminately, all types of cases.

The plan as outlined by us would provide a hospital in which more effective work may be accomplished.

Vol. XXXII, No. 6

THE SIGNIFICANCE OF ABNORMALLY SHAPED SUBARACHNOID CISTERNS AS SEEN IN THE ENCEPHALOGRAM*

CORRELATION WITH CLINICAL CASES

By CORNELIUS G. DYKE, M.D., *and* LEO M. DAVIDOFF, M.D.
NEW YORK CITY

INTRODUCTION

THE anatomical and encephalographic appearance of the normal subarachnoid cisterns has been fully discussed in an earlier paper.[5] In that study it was noted that within certain limits the cisterns have a constant size and shape in the encephalogram. Whenever a distinct variation from the normal is evident, clinical studies frequently point to abnormalities accountable for the deformity. The present paper is concerned with an analysis of cases in which definite deformities of the cisterns were noted.

Often the deformity of one or more of the cisterns is the only recognizable abnormality in the encephalogram and its recognition makes the diagnosis and localization of the lesion possible. This is particularly true of tumors arising along the base of the brain. Degenerative lesions, while frequently not confirmed anatomically, often produce clinical disturbances which also support the conclusions drawn from the encephalogram.

CISTERNA MAGNA

In the lateral encephalogram the cisterna magna is sickle-shaped in appearance and of all the cisterns it is probably the most variable in size. Its normal measurements range between 0.5 cm. and 2 cm. at its point of greatest depth which is at the vallecula. Measurements exceeding 2 cm. should be considered abnormal.

In cerebellar tumors definite deformities of this cistern are often found. While patients with tumors in the posterior fossa are seldom examined by encephalography, a few such cases where the tumor could not be localized clinically in the cerebellum exist in this series.

One of these will be briefly summarized here:

Case 1 (N. I. No. 16032). S. B., male, aged thirty, private patient of Dr. C. A. Elsberg. Cystic cerebellar tumor. Admitted May 15, 1933.

Complaint. Headache, nausea and vomiting.

Present Illness. About February, 1933, the patient began to have headache, nausea and vomiting. Following that date he felt dizzy and had some difficulty in walking.

Physical Examination. The patient was a large obese man with a hypopituitary habitus. There was a definite left central facial weakness, slight unsteadiness of gait with a tendency to deviate to the left and a failure to swing the left arm in walking. There was a slight increase of the deep reflexes on the left side with a decrease in the left abdominal reflexes. There was a questionable extensor toe sign of Babinski in the left foot. The eyegrounds as well as the visual fields were normal.

Roentgen Examination. Plain films of the skull were normal.

Encephalograms made after the injection of 70 c.c. of air showed only a small amount to have entered the cranial cavity and this was limited to the subarachnoid space. The cisterna magna appeared flattened and the air over the vermis of the cerebellum formed a straight line rostrally. Air was also present in the subarachnoid space of the spinal canal. The shadow of this air was sharply limited at the upper margin of the arch of the atlas and had a concave contour cephalically (Fig. 1).

About a week later ventriculograms were made. These showed a symmetrical dilatation of the lateral and third ventricles. The aqueduct was also dilated but the fourth ventricle

* From the Roentgenological and Surgical Departments of the Neurological Institute of New York. Read before the Philadelphia Roentgen Ray Society, January 4, 1934.

FIG. 1. Case 1. No. 25083. Cerebellar cyst. The dorsal portion of the cisterna magna is flattened rostrally (arrows) and the spinal part of the cistern is cut off sharply opposite the arch of the atlas (arrow).

was not visualized. From this evidence a tumor of the cerebellum was diagnosed.

Operation. A posterior fossa exploration revealed a large cyst of the cerebellum containing yellow fluid which coagulated, but no tumor nodule was seen. The patient made a prompt, uneventful recovery.

Comment. When the encephalograms were interpreted, the significance of the cutting off of the column of air opposite the arch of the atlas was not recognized. In retrospect, however, it is evident that this deformity of the spinal portion of the cisterna magna was probably produced by the displacement of the cerebellar tonsils into the spinal canal. The narrowing of the cranial portion of the cisterna magna, as well as the flattening of its rostral margin, was also due to the presence of the tumor.

In cerebellar atrophy, the cistern, unlike its appearance in the presence of a tumor in the posterior fossa, is markedly enlarged. This may be illustrated by the following case:

CASE II (N. I. No. 15509). G. S., male, aged fourteen. Cerebellar sclerosis. Admitted March 22, 1933.

Complaint. Difficulty in walking, unsteadiness in the hands, difficulty in speech.

Present Illness. In the Fall of 1928, at the age of nine years, without any immediate known cause, the patient began to complain of fatigue on walking, and his gait became unsteady. This disability progressed in the following months so that he had to support himself on neighboring objects to keep from falling. In 1930 his handwriting was observed to have become irregular. In 1931 his speech became monotonous and he stammered when excited. In 1932 occasional double vision was noted.

Past History. Diphtheria in June, 1927, measles in early childhood; otherwise negative.

Physical Examination. The patient was a fairly well developed and well nourished boy of fourteen. His gait was extremely ataxic; he staggered from side to side and reeled drunkenly. He balanced himself continually with outstretched arms. There was a markedly positive Romberg sign, with falling to the left. He fell when attempting to stand on either foot. In the finger to nose, finger to finger, each finger to thumb, and heel to knee tests, with eyes either open or closed, marked ataxia and dysmetria were present. Adiadokokinesis was evident in the left hand. Picking up objects, buttoning clothes, handwriting were all poorly done. There was stammering and dysarthria when speaking. The deep reflexes were absent and superficial ones present. At times there were bilateral indefinitely positive Babinski signs present. Spontaneous nystagmus was present at rest, none on deviating the eyes. The rest of the examination was negative except for a bilateral pes cavus.

Roentgen Examination. The encephalograms were entirely negative in this patient except for the cerebellum which was atrophic, and the cisterna magna which was enlarged. The greatest depth of this cistern at a point opposite the torcular Herophili measured 3.5 cm., while the cerebellar vermis from the fastigium of the fourth ventricle to the outer margin, as outlined by the air in the cistern, measured only 1.5 cm., thus showing relative proportions which are the reverse of the normal (Fig. 2).

Comment. The marked progressive disturbance in cerebellar function over a period of five years, without evidence of increased intracranial pressure, pointed to a

sclerosis of the cerebellum. This was adequately confirmed by the dilatation of the cisterna magna and fourth ventricle as seen in the encephalogram.

Somewhat similar encephalograms may be seen in cases of hypoplasia of the cerebellum, as the following histories indicate:

Cases III and IV (N. I. No. 16729 and 16730). R. and J. W., male twins, aged fourteen. Cerebellar hypoplasia. Admitted July 19, 1933.

Present Illness. The patients, identical twins, were born prematurely during the seventh month of pregnancy. They cried normally but had difficulty in suckling. From birth they were retarded in their development. They sat up at two years, crawled at two and a half years, and have never walked unaided. They began talking at the age of nine.

Physical Examination. They were unable to stand or walk. Bilateral knee and ankle clonus and positive Babinski signs were present in both boys. There were weakness and spasticity of all the musculature. Mentally they were markedly defective.

Roentgen Examination. Encephalograms: In each patient 85 c.c. of air was introduced. The encephalograms in both cases showed somewhat enlarged lateral ventricles and a marked enlargement of the fourth ventricle. The cerebellar sulci were widened, indicating an underdevelopment of the folia. The cisterna magna was definitely dilated (Fig. 3).

Fig. 2. Case II. No. 24724. Cerebellar sclerosis. There is marked enlargement of the cisterna magna (*A*) and slight dilatation of the fourth ventricle (*B*) indicating a hypoplasia of the cerebellum (*C*).

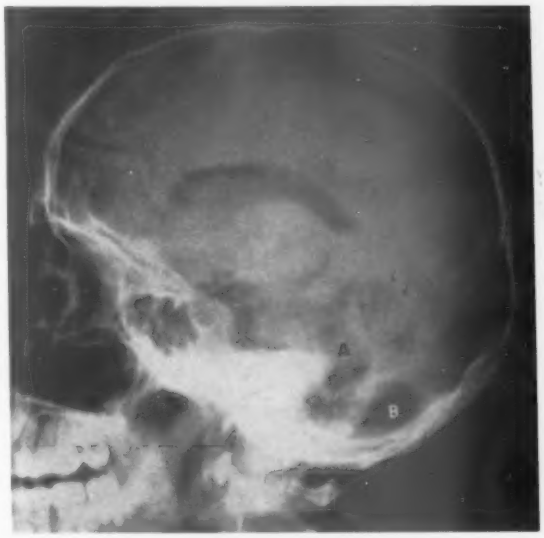


Fig. 3. Case III. No. 25589. Congenital cerebellar hypoplasia. The cerebellar sulci (arrows), fourth ventricle (*A*) and cisterna magna (*B*) are increased in size, the result of hypoplasia of the cerebellum.

Comment. Clinically these patients showed such marked evidence of organic disease of the entire brain that the separate disabilities of cerebellum and cerebrum could not easily be distinguished. In the encephalograms, however, the cerebellar hypoplasia was outstanding.

CISTERNA PONTIS

The cisterna pontis is visualized in a high percentage of encephalograms and its failure to fill with air during encephalography is in itself of some diagnostic significance. Furthermore, in a large series of cases, the distance from the floor of the fourth ventricle (dorsal surface of pons Varolii) to the dorsum sellae varied by only a few millimeters. A measurement which is greater than 4 cm. is usually indicative of an intrapontine tumor, or a mass situated ventral to the pons Varolii. The value of noting any deviations from the normal in this cistern is illustrated in the following cases:

Case V (N. I. No. 14146). M. P., female,

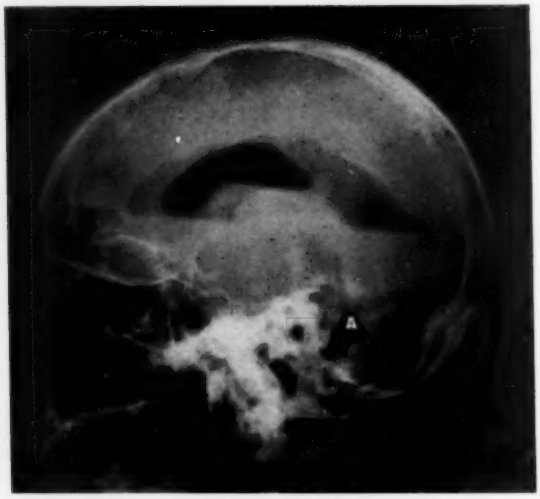


FIG. 4. Case v. No. 25580. Pontine tumor. Note the caudal displacement of the fourth ventricle (*A*), and the aqueduct of Sylvius. The cisternae pontis and interpeduncularis are obliterated.

aged thirty-three. Intrapontine tumor. Admitted October 31, 1932.

Complaints. Drowsiness, double vision and right-sided weakness.

Present Illness. About 1½ years ago the patient began to experience a feeling of fatigue and drowsiness so that she frequently fell into a profound sleep which often lasted twenty-four hours. A year later a progressive right hemiplegia developed. Three months before admission she began to have dizzy spells and diplopia. Very shortly before hospitalization she noticed some weakness of the left arm.

Physical Examination. The patient had a right hemiplegia with positive Babinski sign. Nystagmus to the left occurred spontaneously. Right central facial weakness and diminished right labyrinthine response to cold water irrigation were demonstrable. The palate did not move when stimulated.

Laboratory Tests. All examinations of blood, urine and spinal fluid were negative.

Roentgen Examination. Encephalograms: After injection of 75 c.c. of air, anteroposterior views of the skull showed the lateral ventricles to be moderately and symmetrically dilated. A small fifth ventricle was present. Only a small globule of air was seen in the third ventricle. In the lateral view the posterior portion of the third ventricle was encroached upon from below and the aqueduct of Sylvius as well as the fourth ventricle was displaced dorsally. The basilar cisterns contained no air. *Impression.* Tumor involving the pons (Fig. 4).

Course. Six hours after air injection, the patient became stuporous and continued so for about twelve hours when she gradually returned to her preoperative state. She remained in the hospital for about a month during which a slowly progressive involvement of the 8th, 9th and 10th pairs of cranial nerves developed.

December 3, 1932, she was transferred to the Montefiore Hospital. Here her disease progressed rapidly. The pupils became fixed to light, bilateral pyramidal tract signs occurred with considerable spinothalamic tract involvement. She died of bronchopneumonia January 4, 1933. Unfortunately, premission for necropsy was refused but *the course of the disease left no doubt as to its seat in or adjacent to the pons.*

Comment. In this case the cisterna pontis was obliterated and the measurement from the floor of the fourth ventricle to the dorsum sellae was 0.7 cm. above the maximum of 4 cm.

Another even more striking example of obliteration of the pontine cisterna and an increase in the measurement from the floor of the fourth ventricle to the dorsum sellae was presented by a patient with a large aneurysm of the basilar artery.

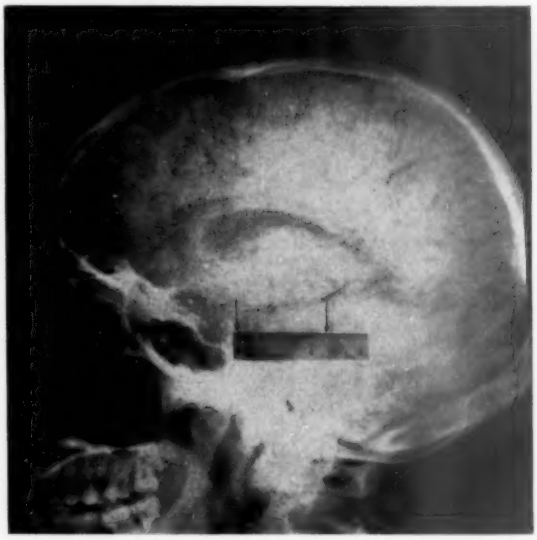


FIG. 5. No. 18462. Illustrating an average normal distance between the dorsum sellae and fourth ventricle.

Case VI (N. I. No. 16244). G. D., male, aged fifty-seven. Aneurysm of the basilar artery. Admitted June 3, 1933.

Complaint. Changes in personality, general weakness, and disturbance of gait.

Present Illness. For two years, the patient had been showing lack of interest in his surroundings, memory loss, and distinct dispositional changes. There had also been a marked unsteadiness in walking.

Physical Examination. There was an ataxic gait, and all tests for coordination were poorly done, especially those involving equilibration. There was a generalized hypertonicity but no exaggeration of the deep reflexes. The latter were somewhat greater on the right than on the left side. A right positive Babinski sign was present. The pupils reacted upon accommodation but very poorly to light. There was a slight left facial weakness and marked bilateral diminution in hearing.

Laboratory Tests. Laboratory tests, including blood and spinal fluid Wassermann reactions were negative, except for the spinal fluid which showed xanthochromia, 4,800 red blood cells, 2 plus globulin, 102 mg. of total protein per 100 c.c.

Roentgen Examination. Encephalograms, after the injection of 95 c.c. of air, showed a symmetrical and generalized dilatation of the lateral ventricles. The third ventricle was dilated but there was a filling defect obliterating the inferior portion of this ventricle, the deformity being most marked on the left side. In the lateral view the posterior portion of the third ventricle was narrowed and the aqueduct of Sylvius and fourth ventricle were displaced caudally. The basilar cisterns contained no air. The distance from the dorsum sellae to the floor of the fourth ventricle measured 4.4 cm. *Impression:* Tumor involving the pons (Figs. 5 and 6).

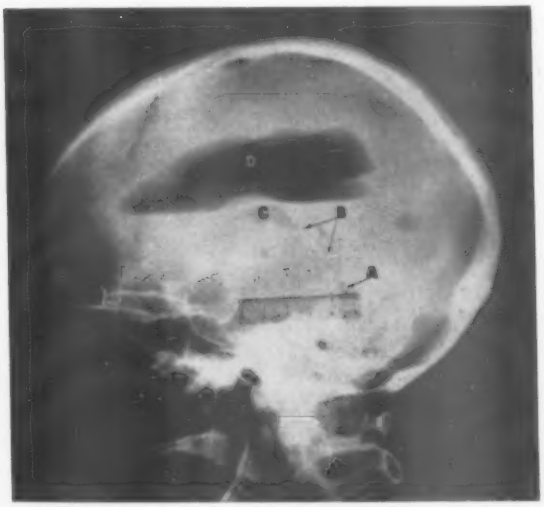


Fig. 6. Case VI. No. 25243. Displacement caudally and dorsally of the fourth ventricle (*A*), aqueduct of Sylvius (*B*) and third ventricle (*C*), by a large aneurysm of the basilar artery increasing the distance between the dorsum sellae and the floor of the fourth ventricle. The cisternae pontis and interpeduncularis are not visualized and the lateral ventricles (*D*) are dilated.

Fig. 7. Case VI. Sagittal section of the brain showing the large aneurysm of the basilar artery (*E*). Compare the fourth ventricle (*A*), aqueduct of Sylvius (*B*) and the third ventricle (*C*) with the shadows of these structures in the encephalogram (see Fig. 6).

Course. Twenty-four hours after air injection the patient became somnolent, had a slight chill and temperature of 102° F. He died five days later.

Necropsy. A large aneurysm of the basilar artery was found displacing the pons to the left as well as dorsally and caudally, accounting for the changes seen in the encephalogram (Fig. 7). There was no evidence of rupture or recent hemorrhage from the aneurysm.

Comment. This case, like the former, showed an obliteration of the cisterna pontis and an increase of the distance between the dorsum sellae and the fourth ventricle above the maximum of 4 cm. The appearance of the brain at necropsy adequately explained the changes seen in the encephalograms, and demonstrated that in cases

with similar encephalograms the diagnosis of a pontine or extrapontine tumor is justified.

Localized dilatations of the cisterna pontis are infrequent, but a few cases with enlargements of this cistern due to atrophy or hypoplasia of the pons Varolii have been recognized in this series of encephalograms. The following is a case in point:

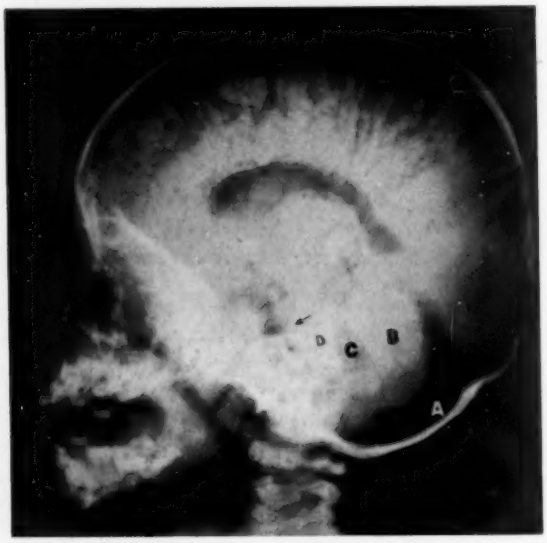


FIG. 8. Case VII. No. 26262. Pontocerebellar hypoplasia. Showing a marked enlargement of the cisterna pontis (arrow) and moderate enlargement of the cisterna magna (*A*). The cerebellum (*B*) is decreased in size from the normal, the fourth ventricle (*C*) is slightly dilated and the pons Varolii (*D*) is definitely hypoplastic.

CASE VII (N. I. No. 17322). A. V., male, aged twenty-one months. Ponto-cerebellar hypoplasia. Admitted October 24, 1933.

Complaint. Inability to walk or talk. Convulsions.

Present Illness. The patient was born normally and remained well until four months of age. At this time he began to have spells consisting of clenching of the fists and a forward doubling of his body. These increased in frequency up to as many as 30 in one day. The spells were always very brief in duration. He never learned to walk or talk and began to sit up at nineteen months.

Physical Examination. The child seemed to notice his surroundings. He was able to sit up, turn over and get up on his hands and knees, but could not stand. There was marked general hypotonicity of the entire body with general diminution of the deep reflexes. Examination was otherwise essentially negative.

Roentgen Examination. Encephalograms showed slight dilatation of the lateral ventricles, the left being larger than the right. They were in their normal position. The third ventricle, aqueduct and fourth ventricle were at the upper limits of normal in size. The cisterna magna was enlarged, and the cisterna pontis was definitely increased in size so that the space occupied by the pons Varolii and cerebellum was distinctly diminished. The other cisterns did not appear abnormal but the cerebral sulci were slightly coarser than usual (Fig. 8).

Impression. Cerebral, cerebellar and pontine hypoplasia or atrophy.

Comment. The age of the patient made a careful examination of the nervous system impossible. The lesion was suggested even from the incomplete clinical study, but the encephalograms clearly demonstrated the presence of a profound organic malformation of the entire brain, which affected especially the pons and cerebellum.

CISTERNA INTERPEDUNCULARIS

This cistern is visualized in the encephalogram in 92 per cent of the cases of the Neurological Institute series. Its failure to fill with air, taken in consideration with other facts, should arouse suspicion of a neighboring lesion. A case with complete obliteration of the cisterna interpeduncularis is presented to demonstrate this point.

CASE VIII (N. I. No. 19129). L. F., female, aged fifty-three, a private patient of Dr. C. A. Elsberg. Bucconeural pouch cyst. Admitted March 6, 1934.

Complaint. Somnolence, failing vision, mental disturbances and generalized weakness.

Present Illness. About April, 1931, the patient began to manifest somnolence followed in a few weeks by disorientation which had progressed up to the time of admission. She was irrational at times, and complained frequently of headache and dizziness. During the same period her visual acuity diminished progressively. Within a few months she began to show some unsteadiness in walking which had also increased. There had been a continued disin-

tegration of the personality, and for about eight months she had been incontinent of urine and feces.

Physical Examination. The patient was disoriented and uncooperative, making complete examination impossible. Speech was mumbled and rambling. No definitely localizing signs were present.

Roentgen Examination. Plain films of the skull were reported negative from another hospital but were repeated immediately prior to the encephalograms. They showed many flecks of calcification above the sella turcica, forming a mass 4.5×4×3 cm. in size.

Encephalograms proved that the lateral ventricles were moderately and symmetrically dilated and in their normal position. The third ventricle was displaced upward. No air was visible in the cisterna interpeduncularis and the superior margin of the cisterna pontis was sharply cut off and had a concave margin dorsally (Fig. 9). *Impression:* Either suprasellar meningioma or bucconeural pouch cyst.

Operation. Through a right transfrontal craniotomy the region of the chiasm was explored but no lesion disclosed. A transcortical incision was then made through the middle frontal convolution. Bulging through the floor of the lateral ventricle a thin-walled cyst was found containing fluid laden with cholesterin crystals.

Comment. In this case the entire cisterna interpeduncularis was obliterated and even the cisterna pontis was deformed. The encephalograms merely confirmed the impression gained from the plain skull films in which the calcification indicated a suprasellar neoplasm. They served, however, to illustrate graphically the type of deformity of the cisterns produced by a large tumor in this location.

The cisterna interpeduncularis, while it usually contains some air following encephalography, often is incompletely filled, without apparent cause. However, in a number of instances, a definite deformity of the partially filled cistern was encountered. This was usually found in association with a tumor in the neighboring region. The most frequent tumor producing such a deformity was the suprasellar meningioma. Such a lesion produced the distortion noted in the next case.

Case IX (N. I. No. 14556). C. F., male, aged forty-one. Suprasellar meningioma. Admitted December 4, 1933.

Complaint. Disturbed vision in the left eye.

Present Illness. About four years before admission, the patient began to notice blurring of vision in the left eye which could not be

Fig. 9. Case VIII. No. 27294. Bucconeural pouch tumor. The third ventricle (arrows) is displaced dorsally, the cisterna interpeduncularis is obliterated and there is a concave defect in the dorsal margin of the cisterna pontis (arrow).

corrected by refraction. One and one-half years ago, he began to suffer from pain over the left eye. This pain was usually accompanied by nausea and was relieved after vomiting.

Physical Examination. The patient was a well developed man showing no demonstrable signs of pituitary dysfunction. The neurological status was negative except for the eyes. These showed primary optic atrophy and a complete defect of the upper half of the left visual field.

Roentgen Examination. Plain films of the skull showed slight atrophy of the dorsum sellae.

Encephalograms after the introduction of 75 c.c. of air showed the lateral and third ventricles to be slightly dilated but otherwise normal. The cisterna interpeduncularis, on the other hand, had a definite concave defect in its cephalic margin. This defect formed an arc

of a circle about 1.4 cm. in diameter. The diaphragma sellae was outlined by air in the ventral portion of the interpeduncular cistern so that one must assume the deformity to have been due to a mass dorsal to the cistern, such

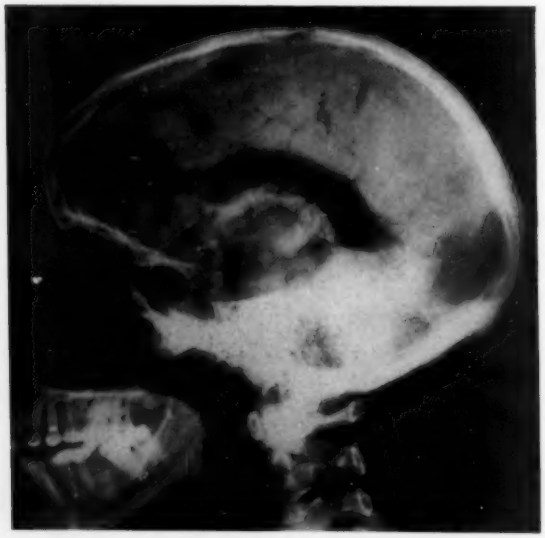


FIG. 10. Case IX. No. 23960. Suprasellar meningioma. Note the concave defect on the rostral margin of the cisterna interpeduncularis (arrow).

as a suprasellar meningioma (Fig. 10), since a pituitary adenoma obliterates the ventral portion of the cistern.

Operation. On December 8, 1933, through a left transfrontal craniotomy, a suprasellar meningioma about 2 cm. in diameter was disclosed.

Comment. This patient, clinically, showed primary optic atrophy with a type of visual field defect which is not characteristic of a chiasmal lesion. Very little help was obtained from plain films of the skull, and the ventricular system after air injection was essentially normal. The deformity of the cisterna interpeduncularis was the only evidence in the encephalogram on which to base a diagnosis. This case emphasizes the importance of a study of the subarachnoid cisterns in the diagnosis of intracranial tumors.

Another case showing a slightly different deformity of the cisterna interpeduncularis is the following one:

CASE X (N. I. No. 17550). B. B., female, aged forty-five, a private patient of Dr. C. A. Elsberg. Suprasellar meningioma. Admitted October 9, 1933.

Complaint. Failing vision, headache.

Present Illness. About five years ago this patient noticed rapid diminution in visual acuity. She soon became aware that the loss was greatest in her temporal fields. About seven years ago she began to have piercing headaches, and more recently she thought that she had grown somewhat unstable emotionally.

Physical Examination. There was nothing unusual about her general appearance, and the neurological status was negative except for the eyes. These showed a primary atrophy of the optic discs, marked reduction in visual acuity, and bitemporal hemianopsia.

Roentgen Examination. Plain films of the skull showed no evidence of disease.

Encephalograms after the injection of 80 c.c. of air showed the ventricular system to be normal in size, shape and position. The cephalic portion of the cisterna interpeduncularis and the cisterna chiasmatis failed to fill with air.

FIG. 11. Case X. No. 26147. Suprasellar meningioma. The cephalic portion of the cisterna interpeduncularis (arrow) is obliterated and the cisterna lamina terminalis (arrows) is displaced dorsally and caudally.

The cisterna lamina terminalis had a concave defect cephalically and ventrally. The other cisterns and sulci appeared normal (Fig. 11). *Impression:* The findings suggested a tumor arising from the tuberculum sellae.

Operation. Through a right transfrontal approach a meningioma was removed from the suprasellar region.

Comment. In this case there was an obliteration of the anterior part of the cisterna interpeduncularis. There was also a deformity of the cisterna lamina terminalis, which, together with the absence of air in the rostral part of the cisterna interpeduncularis, indicated the presence of a suprasellar tumor, probably a meningioma.

In the following case of a patient with a tumor of the third ventricle, the defect in the cisterns took still a different form.

Case xi (N. I. No. 18021). R. L. C., male, aged nineteen, a private patient of Drs. H. A. Riley and L. M. Davidoff. Epidermoid cyst of the third ventricle. Admitted November 20, 1933.

Complaint. Paroxysms of severe headache.

Present Illness. This boy was well until ten months ago when he began to have attacks of severe headache. These came on when he was studying with his head bent forward, and were usually relieved by lying down in a supine position. More recently he began to complain of blind spots before his eyes, nausea, and numbness of the hands.

Physical Examination. The patient was an intelligent, normal-looking young man. Neurologically he showed nothing abnormal aside from a slight increase of the deep reflexes on the left side and a bilateral papilledema of about 2 diopters.

Roentgen Examination. Plain films of the skull showed the pineal gland to be displaced slightly caudally and ventrally but no other evidence of abnormality was noted.

Encephalograms, after the introduction of 80 c.c. of air, showed a symmetrical dilatation of the lateral ventricles. In the anteroposterior view the third ventricle was not visualized, but in the lateral views air was seen in the caudal portion of this ventricle. Cephalically this air shadow was cut off sharply in a vertical direction. The cisterna interpeduncularis was only partially filled with air and appeared flattened from above. The cisternae chiasmatis and lamina terminalis were entirely obliterated (Fig. 12). *Impression:* Third ventricle tumor.

Operation. Through a right frontal transcortical approach the region of the foramen of Monro was exposed and an epithelial cyst removed from the third ventricle.

Comment. This case demonstrated how a true third ventricle tumor may deform the basal cisterns. This deformity, together with the changes in the shadow of the third ventricle, made possible the localization of the lesion.

A deformity of the cisterna interpeduncularis by a chromophobe pituitary ade-

Fig. 12. Case xi. No. 26526. Epidermoid cyst of the third ventricle. Showing partial obliteration of the cisterna interpeduncularis (arrow) in addition to dilatation of the lateral ventricles (*A*) and cutting off of the air in the caudal portion of the third ventricle (*B*).

noma is demonstrated in the succeeding case:

Case xii (N. I. No. 16557). R. B., female, aged forty-seven. Chromophobe pituitary adenoma. Admitted August 6, 1933.

Complaint. Failing vision and nervousness.

Present Illness. Two years before admission, this woman began to notice diminution in visual power in her left eye. A year later, the right eye became similarly involved. The disturbance took the form of a cloud over the outer half of each field of vision, which in the left eye had spread, at the time of entrance into the hospital, to include most of the nasal field as well. During the same period, she became emotionally unstable. She had gained considerable weight during these two years. Her

menopause occurred at forty-one years of age.

Physical Examination. The patient was a short, obese, pale white woman with dry hair and skin suggesting a hypopituitary status. Neurologically, she showed advanced primary atrophy of the optic nerves with marked diminution of visual acuity, especially in the left eye, and a bitemporal hemianopsia.

Roentgen Examination. Plain films of the skull showed no evidence of generalized increase of intracranial pressure. The sella turcica was markedly enlarged and atrophic. *Impression:* Chromophobe pituitary adenoma.

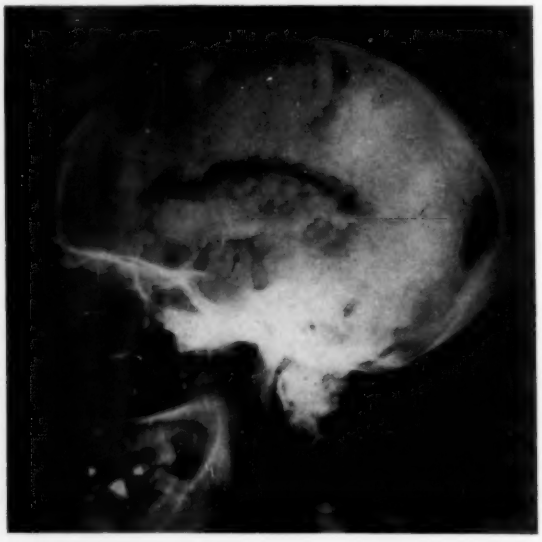


FIG. 13. Case XII. No. 25480. Chromophobe pituitary adenoma. The cisterna interpeduncularis is displaced dorsally (arrow) and the cisterna chiasmatis (*A*) is displaced dorsally and rostrally.

Encephalograms after the introduction of 65 c.c. of air showed the lateral ventricles, the aqueduct of Sylvius and fourth ventricle to be normal. The third ventricle was somewhat dilated. In the lateral view, the cisterna interpeduncularis showed a definite concave defect in its cephalic and ventral margins (Fig. 13), and the entire cistern was displaced dorsally.

Course. The patient was given a series of roentgen treatments to the region of the tumor and showed, as a result, considerable improvement in her visual acuity and fields.

Comment. Although only one case of pituitary adenoma with encephalographic findings is presented here, a total of 12 such cases exist in this series. Whenever tumors arising from the pituitary body expand beyond the confines of the sella turcica, the cisterna interpeduncularis is displaced dorsally and the ventral portion of the cistern may be obliterated. Heidrich[6] reported a similar case in which there was a dorsal displacement of this cistern in the encephalogram and which showed a large encapsulated hypophyseal tumor at post-mortem examination. This deformity is in distinct contrast to the type of deformity produced by the suprasellar meningiomas and tumors of the third ventricle, which compress the interpeduncular cistern from above.

The following case is included to illustrate a slight deformity of the cephalic border of the cisterna interpeduncularis and obliteration of the cisterna chiasmatis.

CASE XIII (N. I. No. 16406). E. B., male, aged three years, a private patient of Drs. Zabriskie and Elsberg. Optic chiasm glioma. Admitted June 19, 1933.

Complaint. Increasing prominence and turning outward of the right eye.

Present Illness. About seven months ago, the child's mother noticed that his right eye seemed to rotate outward and after scrutinizing it closely she saw that it bulged slightly. Both these signs were slowly progressive until admission to the Institute. For a few days prior to entering the hospital he had complained of pain in the right eye.

Physical Examination. The patient was a well-developed small boy with a fairly large head. There was a moderate degree of exophthalmos with a transient third nerve weakness on the right. This eye appeared to be blind although the pupil reacted to light. The disc on this side showed pallor with a superimposed edema. There were no other neurological changes.

Roentgen Examination. Plain films of the skull showed a hollowing out of the tuberculum sellae and an enlargement of the right optic foramen. *Impression:* Optic chiasm glioma extending to the right.

Encephalograms showed a normal ventricular system. The cephalic border of the cisterna interpeduncularis presented a concave defect cephalad, indicating a mass in the region of the optic chiasm (Fig. 14). The cisterna chiasmatis was not visualized.

Operation. A right transfrontal exploration was done, exposing a glioma of the optic chiasm and the right optic nerve.

Comment. The encephalogram, indicating a tumor in the region of the chiasm, supported the impression of an optic chiasm glioma gained from the appearance of the sella turcica and the optic foramina in the plain films. This diagnosis was further confirmed at operation.

CISTERNA AMBIENS AND CISTERNAE FOSSAE SYLVII

Deformities of the cisterna ambiens may be of considerable aid in the localization of cerebral neoplasms as the next case shows.

Case XIV (N. I. No. 17039). H. W., male, aged thirty-eight. Left temporal glioblastoma multiforme. Admitted August 25, 1933.

Complaint. Headache, weakness, mental depression.

Present Illness. This man was well until July 5, 1932, when he was injured in an automobile accident. One week later, he complained of nausea and then had a convulsive seizure. This was generalized in character, and consciousness was lost for two hours. Since this seizure he had been quite depressed mentally. This became more marked in April, 1933, when he began to have tremors of the arms and body. In June, 1933, he began to have headaches. On August 3, the pain became very severe; he was irrational and had to be restrained. Lumbar puncture relieved the pain considerably.

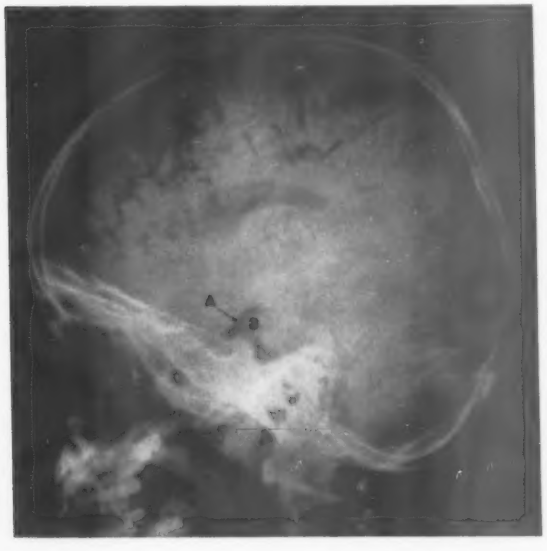


Fig. 14. Case XIII. No. 25345. Optic chiasm glioma. The rostral margin of the cisterna interpeduncularis (*A*) has a concave filling defect due to the tumor. The cisterna chiasmatis is not visualized.

Fig. 15. Case XIV. No. 25824. Left temporal glioblastoma multiforme. Anteroposterior view showing the unusually large collection of air over the left island of Reil and its dorsal displacement.

Physical Examination. The patient was poorly nourished and showed a definite right-sided hemiparesis with a tremor of the right hand. No papilledema was present, but the visual fields showed a right lower quadrant homonymous defect.

Roentgen Examination. Plain films of the skull showed a slight atrophy of the dorsum sellae but were otherwise normal.

Encephalograms failed to show any air within the ventricular system. A number of cerebral sulci were visualized and these appeared normal. The cephalic portion of the cisterna ambiens on the left side was short, broader than usual, and displaced upward. The air in the lateral portion of the left cisterna fossae Sylvii over the island of Reil was increased in amount and definitely displaced dorsally (Figs. 15 and 16).

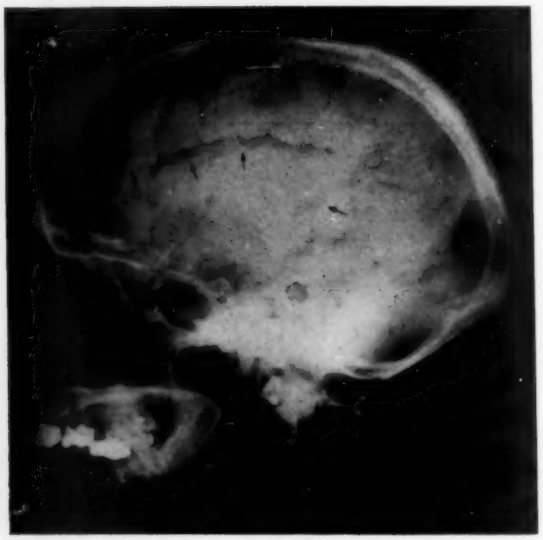


FIG. 16. Case XIV. No. 25824. Lateral view showing the rostral displacement of the air over the island of Reil (arrows) and the broad, short cephalic extension of the cisterna ambiens on the left (arrow).

Later on ventriculography was done. These films showed a displacement of the ventricles to the right.

Operation. A left temporal craniotomy disclosed a deep temporal lobe tumor which, on histological examination, proved to be a glioblastoma multiforme.

Comment. The salient features of the encephalograms in this case were the deformities and upward displacement of the cephalic portion of the cisterna ambiens and the lateral portion of the cisterna fossae Sylvii on the left side. These abnormalities, in spite of the failure of air to enter the ventricles, should be sufficient to make a diagnosis of a tumor and its location.

The following case of brain tumor demonstrates the localizing value of a deformity in the cisterna fossae Sylvii:

CASE XV (N. I. No. 15762). R. E., female, aged thirty-two. Left frontoparietal astrocytoma. Admitted April 19, 1933.

Complaint. Right-sided convulsions and right-sided paralysis.

Present Illness. About twelve years ago, the patient began to have right-sided Jacksonian seizures. Eleven years ago, a left craniotomy was done which revealed only a slightly congested brain. She was improved for several months, but then the attacks recurred, beginning often with disturbance of speech and followed by clonic movements of the right side of the face, the right arm and leg, and finally unconsciousness. Four years previous to admission she began to suffer from progressive weakness and loss of sensation in the right hand, arm and leg.

Physical Examination. The patient showed no signs of increased intracranial pressure. The optic discs were normal. She had a right hemiplegia involving the upper extremity more than the lower, with corresponding changes in the reflexes. No demonstrable aphasia was present.

Roentgen Examination. The encephalograms showed the lateral and third ventricles to be displaced to the right. Air was present over the left island of Reil and this had a concavity dorsolaterally on its superior limb indicating that part of the tumor was superficial to the insula. The air over this structure should form a straight line in the anteroposterior view. In addition, the left temporal horn was obliterated in its cephalic half and the rostral portion of the cisterna ambiens on the left was not visualized (Fig. 17).

Operation. The old left craniotomy scar was reopened and a fibrillary astrocytoma was found involving the cortex and deeper structures of the frontoparietal region.

Comment. The important consideration in this case was the location of the tumor, particularly so since it involved the left cerebral hemisphere. The encephalogram gave accurate information that the tumor, at least in part, was situated lateral and dorsal to the Sylvian fissure and therefore that part of it probably presented on the surface of the brain. This was the actual fact as disclosed at operation. The localization of the tumor in a superficial position was made possible by the recognition of the concave deformity of the air shadow over the dorsolateral portion of the island of Reil.

DISCUSSION

Encephalography, as a rule, is reserved for those cases of disease of the brain in which the nature or location of the lesion requires some elucidation, and in which intracranial pressure is not markedly in-

creased above the normal. Certain cases of brain tumor fall into this category. These are, especially, tumors along the base of the brain which do not obstruct the cerebrospinal fluid pathways until they reach a large size. These cases, moreover, because of their benign character and slow growth (suprasellar meningiomas) or infiltrating qualities without much destruction of nerve tissue (pontine gliomas) often fail to produce sufficient clinical signs for diagnosis. Finally, in encephalograms in these cases, the ventricles often show no abnormalities or only a slight symmetrical dilatation. This makes the diagnosis extremely difficult unless other criteria are used. After examining large numbers of encephalograms and noting the variations in size, shape and position of the subarachnoid cisterns, it has been possible to recognize deformities and changes beyond the normal variations in these structures and to interpret these abnormalities in relation to the disease process. Thus, another criterion has been added to aid in the diagnosis of tumors, aneurysms, degenerative or hypoplastic lesions in structures neighboring upon the cisterns.

Occasionally, even tumors of the cerebellum occur which give no signs of increased intracranial pressure nor sufficiently clear localizing signs to permit an accurate clinical diagnosis. Case I presented such a problem and encephalograms revealed a flattening of the cisterna magna over the vermis of the cerebellum and a deformity of the spinal portion of this cistern due to a displacement of the cerebellar tonsils into the upper portion of the spinal canal. To be sure, the significance of these changes was not recognized at the time, but in retrospect it is evident that these deformities were due to the cerebellar tumor.

In a similar manner, obliteration and deformities of the cisterna pontis have been found in association with tumors involving the pons; in one case (Case VI) with an aneurysm of the basilar artery. It is possible, moreover, for tumors arising more

FIG. 17. Case XV. No. 24889. Left frontoparietal fibrillary astrocytoma. The tumor is causing the border of the superior limb of air over the left island of Reil to be concave dorsolaterally (arrow). This indicates that at least part of the tumor is superficial to the island of Reil. The margin should be straight. The lateral and third ventricles are displaced to the right.

cephalically to deform the cisterna pontis, if they grow to sufficient size (Case VIII).

The cisternae interpeduncularis, chiasmatis and lamina terminalis may be affected individually or collectively by tumors in the region of the optic chiasm or even of the third ventricle. Meningiomas arising from the tuberculum sellae are particularly prone to produce defects of these cisterns (Cases IX and X). The cisterna interpeduncularis is chiefly involved. Its cephalic margin becomes displaced caudally and often has a concave defect rostrally. Tumors of the pituitary body (Case XII), on the other hand, displace the cisterna interpeduncularis dorsally, while tumors of the third ventricle displace the cisterna interpeduncularis ventrally (Case XI). From this it is evident that the origin of the tumor may often be predicated from the type of deformity of the cistern.

Gliomas of the optic chiasm may also deform the cisterna interpeduncularis but this deformity is smaller and more discrete (Case XIII). All these lesions usually obliterate the cisterna chiasmatis entirely which is probably due to its close relation to the primary seat of the tumor, and its small size. Occasionally, however, in the presence of a pituitary adenoma (Case XII) this cistern is visualized, and is found displaced rostrally. The cisterna lamina terminalis, when visualized in the presence of suprasellar meningiomas, is displaced caudally and dorsally (Case X). Such a deformity, when seen, is of great value, but often this cistern is not visualized in the presence of a tumor in the chiasmal region.

Hypoplastic and degenerative lesions of parts of the brain neighboring upon the subarachnoid cisterns are seen more often near the cisternae pontis and magna. The commonest of this group of lesions is degeneration or hypoplasia of the cerebellum. To a much lesser extent degeneration or hypoplasia of the pons may be demonstrable in the encephalogram. The recognition of these abnormalities aids in the correct classification of many clinically obscure neurological conditions.

SUMMARY AND CONCLUSIONS

In the course of examination of 1,300 encephalograms certain deviations from the normal were noted in the subarachnoid cisterns. Many of these deformities were easily recognized as being due to neighboring tumors, degenerative or hypoplastic diseases. Other deviations were slight and difficult to interpret. Their significance was only appreciated as a result of close familiarity with the normal variations in the size, shape and position of these spaces.

REFERENCES

1. DAVIDOFF, L. M., and DYKE, C. G. An improved method of encephalography. *Bull. Neurol. Inst. New York*, 1932, *2*, 75–94.
2. DYKE, C. G., and DAVIDOFF, L. M. The demonstration of normal cerebral structures by means of encephalography. 1. The choroid plexuses. *Bull. Neurol. Inst. New York*, 1932, *2*, 331–346.
3. DAVIDOFF, L. M., and DYKE, C. G. The demonstration of normal cerebral structures by means of encephalography. 2. The corpora quadrigemina. *Bull. Neurol. Inst. New York*, 1933, *3*, 138–146.
4. DAVIDOFF, L. M., and DYKE, C. G. The demonstration of normal cerebral structures by means of encephalography. 3. The cerebral convolutions and sulci. *Bull. Neurol. Inst. New York*, 1933, *3*, 147–189.
5. DYKE, C. G., and DAVIDOFF, L. M. The demonstration of normal cerebral structures by means of encephalography. 4. The subarachnoid cisterns and their contents. *Bull. Neurol. Inst. New York*, 1934, *3*, 418–445.
6. HEIDRICH, L. Weiterer Beitrag zur Frage der Darstellung suprasellarer Hypophysentumoren im Encephalogram. *Beitr. z. klin. Chir.*, 1929, *145*, 628–634.

Vol. XXXII, No. 6

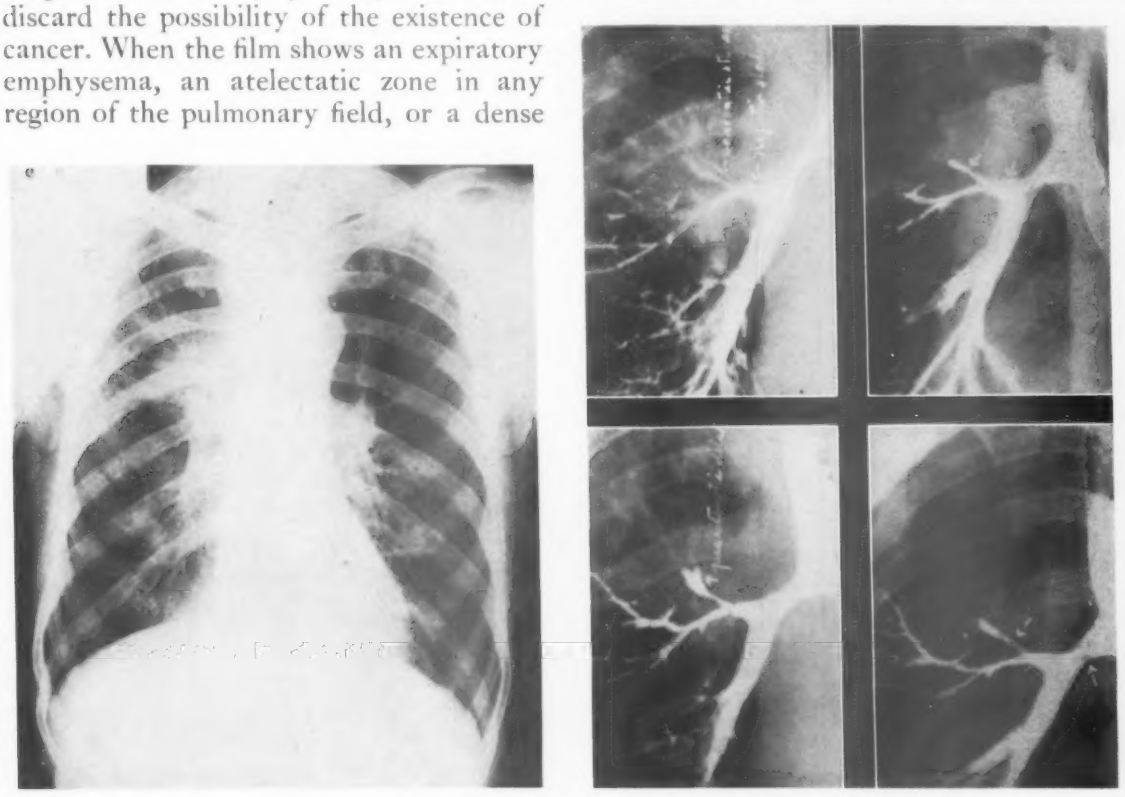
SERIAL BRONCHOGRAPHY IN THE EARLY DIAGNOSIS OF BRONCHIAL CARCINOMA*

By PEDRO L. FARIÑAS, M.D.
HAVANA, CUBA

BRONCHOGRAPHY under roentgenoscopic control permits a diagnosis of bronchial carcinoma in its early stages and should be used in all cases in which there is a clinical suspicion of a bronchogenic carcinoma.

As has been stated by some American authors, a negative roentgenogram of the lungs should not be, by itself, sufficient to discard the possibility of the existence of cancer. When the film shows an expiratory emphysema, an atelectatic zone in any region of the pulmonary field, or a dense shadow in the neighborhood of the hilus, we should use serial bronchography to discover the possible existence of bronchial carcinoma.

A roentgenogram made after the injection of iodized oil has little value. Roentgenoscopic examination, directing the injection of the iodized oil through a rubber sound into the bronchus, as recommended

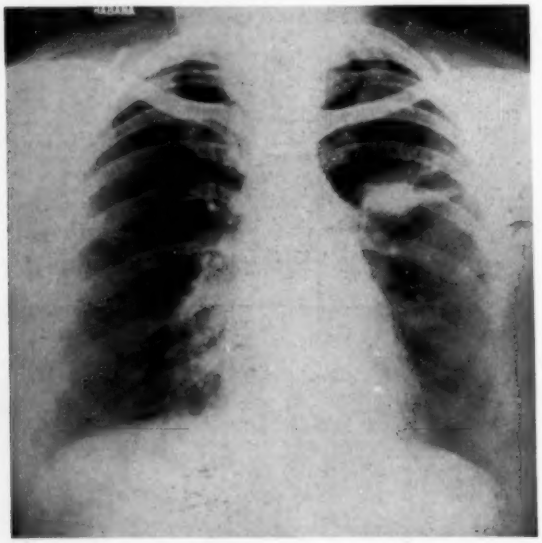


a *b*

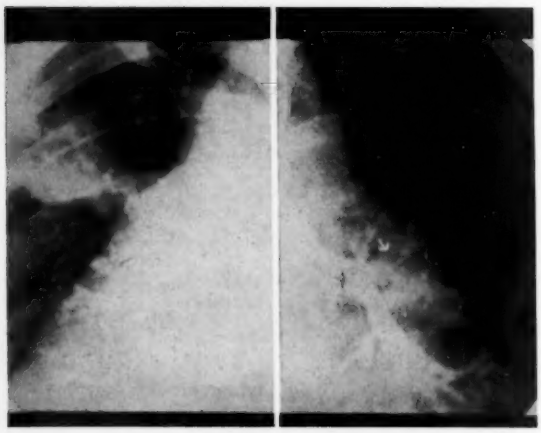
FIG. 1. Case 1. Patient, aged sixty-two. Chronic bronchitis. A year ago the patient complained of pain in the chest with irregular fever, cough and loss of weight. Two months ago the pain increased, and the sputum contained blood. The plain roentgenogram, *a*, shows a small dense area with diffuse borders at the upper part of the right hilus. The bronchograms, *b*, show a negative shadow at the beginning of the main bronchus of the upper right lobe and a concentric stenosis at the upper bifurcation. A prestenotic dilatation is seen above it. Serial bronchography is necessary in order to show the length of the stenosis. Bronchoscopy: Infiltrating tumor of the main right bronchus of the right upper lobe at its entrance, with marked prominence in the lumen of the bronchus. Biopsy: Carcinoma.

* Read before the American Congress of Radiology, Chicago, Ill., Sept. 25–28, 1933.

by Huguenin, is very helpful; but in cases where there are neoplastic changes which do not completely obstruct the bronchus, it is necessary to take a series of roentgenograms at the best angle possible, so that we can study, with certainty, any small alteration of the aspect and contour of the bronchus.



a



b

FIG. 2. Case II. Patient, aged fifty. In November, 1932, the patient had an attack of influenza with blood in the sputum. After recovery the fever and the bloody sputum continued. The plain roentgenogram, *a*, shows an atelectatic zone in the upper part of the left hilus. Bronchography, *b*, shows filling defect "notch" at the beginning of the upper left bronchus with incomplete stenosis. It was necessary to continue injection with the patient in the Trendelenburg position in order to make it possible for the iodized oil to pass through the stenosis.

TECHNIQUE

After cocaine anesthesia of the pharynx, larynx, and the larger nasal fossa, we pass through the latter a soft urethral sound (Nélaton No. 15 or 16) which enters the larynx. It is inserted for a distance of about 14 cm. in order to reach the tracheal bifurcation. If the roentgenogram shows a suspicious shadow, which should be investigated, we incline the patient toward that side and push the sound into the corresponding bronchus. If there is no shadow in the film to guide us, we incline the patient toward the right side, so as to begin our examination with the right bronchus. A small amount of cocaine solution is injected through the sound to anesthetize the bronchial mucosa and thus avoid coughing.

In this condition the patient is taken to the roentgenoscopic room and placed on the table. We verify the position of the sound in the bronchus and adjust it so that it will be more or less in front of the entrance to the bronchial tube corresponding to the lobe in which we suspect the existence of carcinoma. The patient is turned slightly towards the side of the lesion. The position of the table is changed depending upon the particular lobe to be studied. If it happens to be in the superior lobes, we use the Trendelenburg position; for the median lobes a position more or less horizontal, and for the inferior lobes the table is raised but always with the patient lying down.

We watch the screen very closely as the main bronchus is filled, and likewise its principal branch leading to the region suspected. The patient is gradually turned from one side to the other in order to observe these bronchi at various angles. Several films are exposed in these different positions at whatever moment we wish to record what we observe on the fluoroscopic screen. All this year we have followed this routine in our hospital work as well as in our office, and we have not had a single accident.

To make a series of films under roentgenoscopic control we have constructed a small device similar to that which we use for serially studying the duodenum; this device we attach to the fluoroscopic screen frame.

The bronchographic aspect of bronchial carcinoma varies with the type of the

tumor. In the polypoid form of tumors showing a marked prominence in the lumen of the bronchi, the bronchographic shadow is a filling defect. When seen "en face" it appears as a negative shadow, round or irregular, due to the displacement of the oil by the tumor. The defect is permanent, but not very distinct during the roentgenoscopic examination, and it is necessary to take a series of roentgenograms at different angles in order to record it. When the defect is seen in profile, the shadow appears as an irregular notch in one border of the bronchus. This type of tumor is found mostly in the main bronchi, and can be easily demonstrated; but when in the small bronchi, it is very difficult to show it, especially when other small filled bronchi are superimposed.

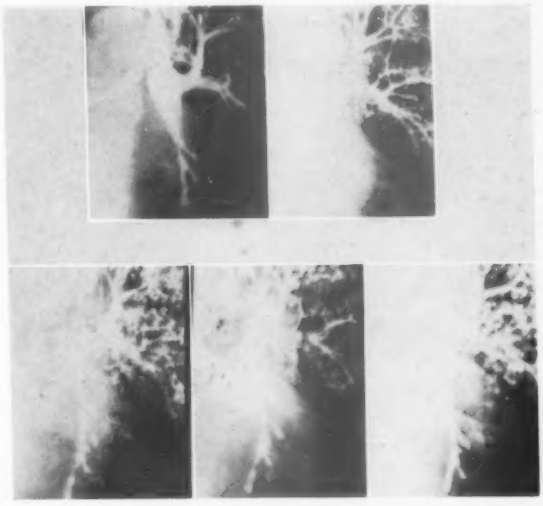
In the infiltrating type the bronchographic shadow is that of an incomplete concentric stenosis with irregular borders, generally occupying the bronchi to a large extent.

This type of tumor is usually seen in the main bronchi, and extends along its branches. When it is found in the small bronchi, it is necessary to continue the injection in order to show the stenosis to its full extent; also the prestenotic dilatation, because the oil enters through the stenosis very slowly.

When the process is more advanced the stenosis is complete and we can see the arrest of the dark column at a point.

The bronchial tubes of the other lobes

a



b

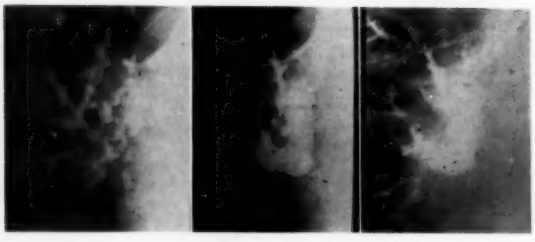
c

Fig. 3. Case III. Patient, aged fifty-five. Cough and expectoration with blood since January, 1933. The plain roentgenogram, *a*, shows a dense area in the right hilus. The bronchograms, *b*, show concentric stenosis of the right bronchus below the bronchus of the upper lobe. The infiltration extends to the bronchi of the median and lower lobes. Bronchoscopy: Neoplastic infiltration of the right bronchus from below at the entrance of the bronchus of the upper lobe. Six months later, *c*, the process has the same extent. The mass at the hilus was not visible at this time, proving it to be an atelectasis. Biopsy: Carcinoma.

fill regardless of the position of the patient; and if we continue the injection, we will see the bronchi of the other side filling, although that side is elevated.

At the point of obstruction the walls of the bronchus are irregular, due to the malignant infiltration that may extend to the surrounding parenchyma.

a



b

FIG. 4. Case IX. Patient, aged sixty-three. For the last eighteen months the patient has had pain in the right side of the chest radiating to the shoulder of the same side, with fever and bloody sputum. The plain roentgenogram, *a*, shows an excavated mass at the right hilus. Bronchography, *b*, shows cavity with irregular borders at the right hilus. When the patient coughs the cavity empties itself. Bronchoscopy: Ulcerated tumor of the right bronchus starting below the bronchus of the superior lobe. Biopsy: Carcinoma.

In some cases of bronchial cancer, the walls of the bronchi become ulcerated and instead of giving rise to an obstruction, the necrosis forms cavities of various size, *but always irregular*. Their bronchographic aspect is that of a cavity of irregular form that can be distinguished from annular bronchiectasis on account of its irregular contour. This type is usually seen at the hilus. In one case we have seen multiple cavities with irregular borders, at the base of the lung, surrounded by an extensive infiltrated zone. These cavities may be as easily filled as the bronchiectatic ones, from which they are distinguished on account of their irregular borders; whereas, in a case of abscess of the lungs, the cavity usually does not fill. Bronchoscopy and biopsy are indispensable in making the differential diagnosis.

Bronchial carcinoma situated far from the main bronchi gives two different aspects during the bronchographic examination. When the tumor is relatively near the large bronchi, a compression of the main, second and third order bronchi is observed.

It is important to prolong the examination in order to ascertain that we are not confronted with a tumor of that particular bronchus, but that, in reality, it is the compression made by the tumor nearby, thus making it difficult for the oil to pass through the compressed area.

When the tumor is situated far from the large bronchi, the displacement of the bronchial tree is complete and the very small bronchioles and the alveolar dissemination can be seen around the tumor mass.

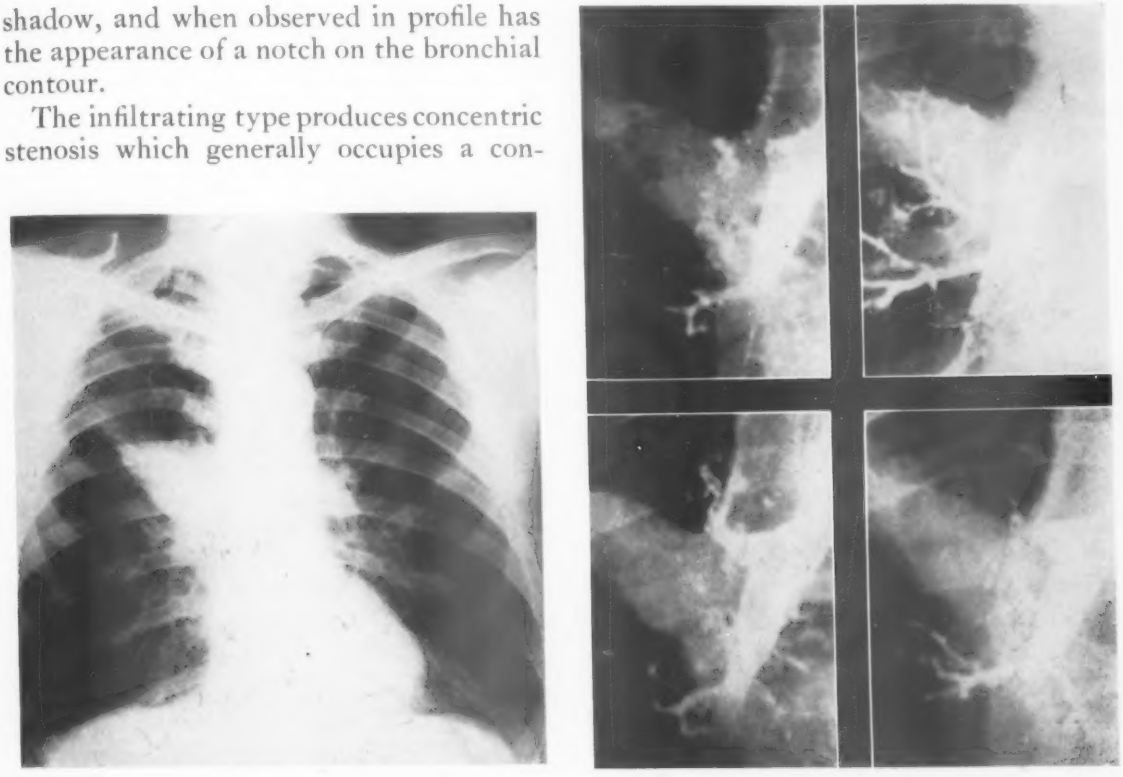
CONCLUSIONS

1. In order to make a diagnosis of bronchogenic carcinoma in its early stages, we must consider very important serial bronchography under roentgenoscopic control as we have used and recommended it.

2. The roentgenological signs of bronchial carcinoma will change according to the type of tumor. The polypoid type shows a filling defect which, when observed "en face," manifests itself as a negative

shadow, and when observed in profile has the appearance of a notch on the bronchial contour.

The infiltrating type produces concentric stenosis which generally occupies a con-



a *b*

Fig. 5. Case xi. Patient, aged seventy-five. For the last year the patient has had pain in the right side of his chest radiating to the shoulder of the same side. The plain roentgenogram, *a*, shows a mass with definite borders at the right hilus. Bronchography, *b*, shows compression of the main right bronchus and displacement of the bronchus of the right upper lobe. At the beginning of the injection it appears as if there were an obstruction of the bronchi by an intrinsic tumor, but continuing the injection for some time it is seen to be only a compression and displacement of the bronchus by the tumor. Bronchoscopy: Flattening of the bronchus at the level of the orifice of the bronchus of the middle lobe with submucous infiltration. Biopsy: Carcinoma.

siderable portion of a large bronchus extending along its branches.

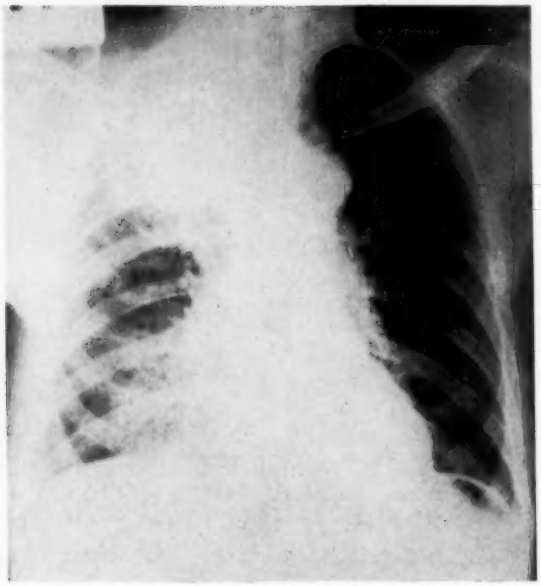
The necrotic type produces irregular bronchial cavities with diffuse borders.

When the tumor is located near the large bronchi it may compress and displace them; when the tumors are very far away they displace the bronchioles and the parenchyma.

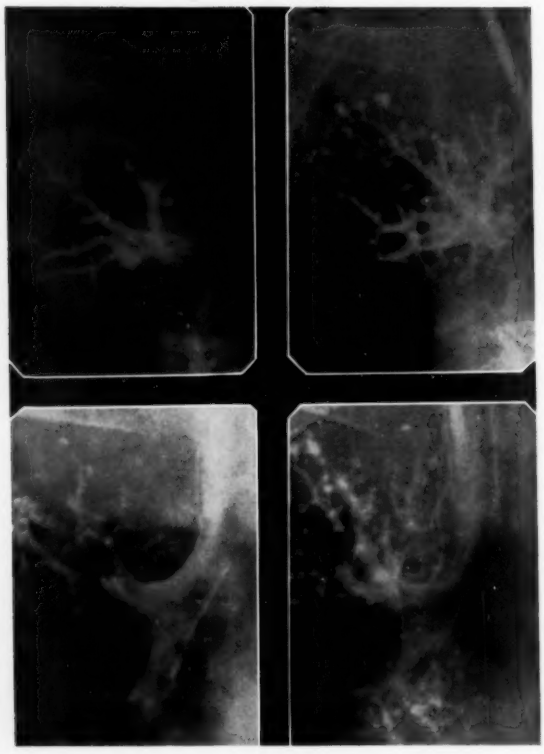
3. The negative shadows, the notches, the concentric stenosis, and the irregular bronchial cavities with diffuse borders (produced by destruction of the bronchial walls), are the signs of bronchogenic carcinoma in its early stages.

REFERENCES

1. Huguenin, René. Le cancer primitif du poumon. Masson et Cie, Paris, 1928.
2. Huguenin, R., and Delarue, J. Importance diagnostique de la bronchoscopie radiologique dans les cancers primitifs du poumon. *Paris méd.*, 1933, *1*, 167–172.
3. Piaggio Blanco, R., and García Capurro, F. Diagnostico de las obliteraciones bronquiales por la broncografía lipiodolada. *Rev. de tuberc. d. Uruguay*, 1932, *2*, 347–374.
4. García Capurro, F. La broncografia contrastada. Inyeccion de substancias opacas con sonda semi-rígida bajo control radioscopico. *Rev. de tuberc. d. Uruguay*, 1931.
5. Fariñas, P., Castillo, P., and Basterrechea, C. Sobre el diagnóstico precoz del cáncer del pulmón. *Vida nueva*, May, 1932.

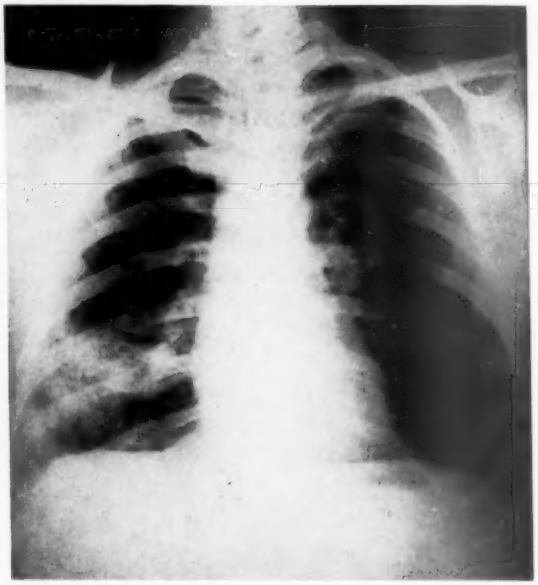


a

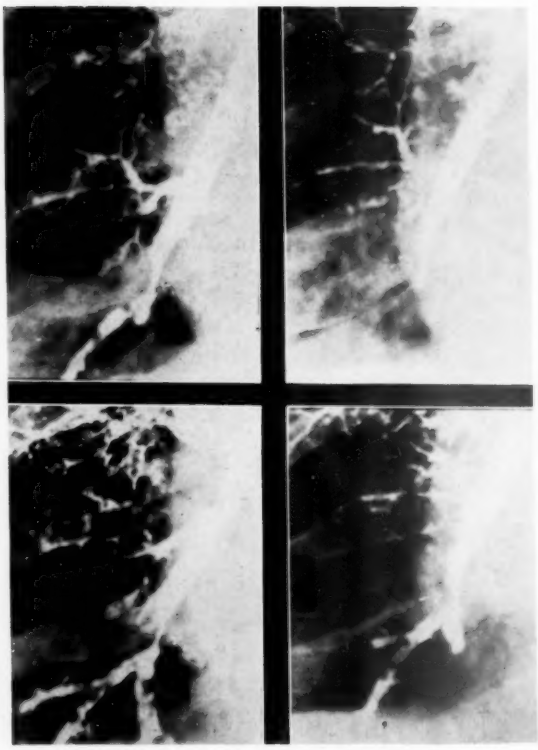


b

FIG. 6. Case XIII. Patient, aged fifty-eight. For the last eight months the patient has had pain in the right shoulder which has gradually increased. The plain roentgenogram, *a*, shows a large opaque area in the right apex and infraclavicular region. Bronchography, *b*, shows displacement of the bronchioles by the tumor.



a



b

FIG. 7. Case XIV. M. G. Chronic bronchitis. Three months ago fever, cough, bloody expectoration. The first roentgenogram was negative. The second roentgenogram, *a*, shows an atelectatic zone at the right base. Bronchography, *b*, shows an incomplete stenosis of the terminal portion of the right main bronchus. Bronchoscopy: Ulcerated infiltration of the last portion of the right main bronchus. Biopsy: Carcinoma.

Vol. XXXII, No. 6

PRACTICAL OBSERVATIONS ON THE USE OF IODIZED OIL IN BRONCHOGRAPHY*

By L. R. SANTE, M.D.
ST. LOUIS, MISSOURI

THE injection of iodized oil in the lungs introduces an oily substance foreign to these structures. Large quantities can be introduced with apparent impunity; in fact, the tolerance of the bronchial tissues for this substance is quite amazing.

The widespread, almost indiscriminate, use of iodized oil in recent years should cause us to pause to consider any possible deleterious effect which this practice may have on the lung structure. We know from the experimental work of Crandall and Walsh[5] that iodized oil, left in prolonged contact with serous surfaces, causes irritation and fibrinous reaction. When introduced into the pericardial sacs of dogs and allowed to remain for several weeks, fibrinous pericarditis of a pronounced degree developed. Similar reactions followed the prolonged contact of iodized oil with pleura, peritoneum and joint surfaces. Introduction of iodized oil into the knee joint in human beings by Burman, Tunick and Pomeranz[4] resulted in pain and limitation of motion. Mention has even been made (Lash[7]) of the development of peritoneal lipiodol cyst in human beings.

It might be well for us, therefore, to consider briefly what happens to iodized oil injected into the lung. In intratracheal injection for bronchography the oil is inserted into a tube lined with secreting mucous membrane, of much different structure than the serous surfaces lining the other cavities. The cough reflex also serves as a mechanism for its expulsion, preventing prolonged contact with the lining membrane of the bronchi. That portion which ultimately gets into the air sacs, however, is under much different conditions in this location than when in the bronchi. Iodized oil injected into the trachea descends by gravity to the region of the smaller bronchioles beyond which it cannot descend by gravity alone, since the entrapped air in the terminal alveolar structures serves as a cushion of air which cannot escape (Fig. 1). The less viscid the oil, the farther down in the bronchial tree the oil will descend by gravity alone; conversely, the greater the viscosity of the oil, the more limited its immediate penetration (Bloch[1]). That the viscosity of the oil within practical limits is not the all important factor in filling the finer lung structure is evident from the fact that quite as good filling of these structures can

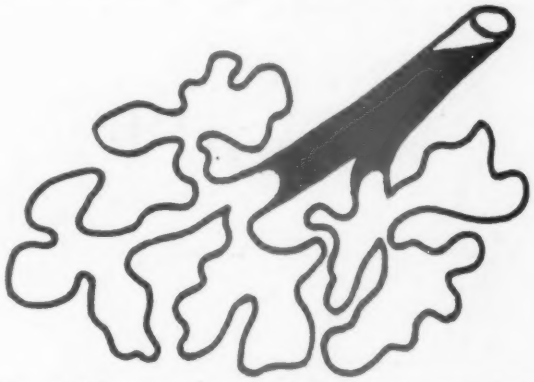


FIG. 1. Diagram of terminal respiratory unit showing bronchiole and alveoli immediately after injection of lipiodol. Iodized oil, injected into the bronchi, descends by gravity to this position, but can go no farther owing to the cushion of air entrapped in the air cells.

be made ultimately with heavy as well as with light oils. Even if the viscosity of the oil were reduced to that of water, immediate filling of the finer lung structures would not be possible since the residual air in the alveoli would prevent its entrance. For practical purposes, the oil may be considered as a plastic foreign body obstructing the bronchiole. In this instance, as in other cases where a bronchus is obstructed by a

* Read before the American Congress of Radiology, Chicago, Ill., Sept. 25–30, 1933.

foreign body, the circulating blood soon absorbs the residual air; this causes a decrease in air pressure within the bronchiole and air sacs distal to the point of obstruction (Fig. 2). The oil, however, being of

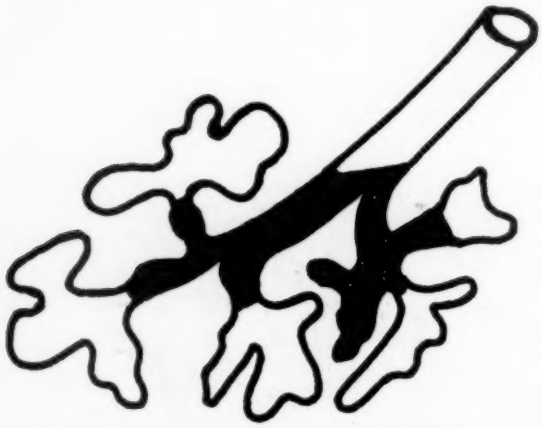


FIG. 2. Diagram of terminal respiratory unit showing bronchiole and alveoli a few minutes later. The iodized oil, obstructing the bronchiole, acts just the same as any other foreign body, with the exception that the oil is plastic being sucked into the alveoli as the air entrapped in them is absorbed by the circulating blood.

plastic rather than solid structure is sucked in by the constantly diminishing air pressure in the distal air structures and finally, with complete absorption of the air, the oil enters and completely fills the terminal

FIG. 3. Diagram of terminal respiratory unit showing bronchiole and alveoli after injected iodized oil has been completely sucked into the terminal air structure. Note that the volume of oil contained in the normal bronchiole is insufficient to fill all of the bronchioles, the others re-expand and engage in normal respiration.

alveolar structure (Fig. 3). It does not seem possible that coughing could account for the entrance of lipiodol into the alveolar structure since residual air always remains in the lung structure and can never be completely expelled even by forced expiration.

There is no more convincing proof of the correctness of this assumption than the observation of Bonnamour and Badolle[2] on the difference in the roentgen picture in the living and in the cadaver. They describe the roentgenographic picture of an injected normal lung in the living as a "tree in full season," while the injected lung in a cadaver is described as "resembling a dead tree." The explanation for this

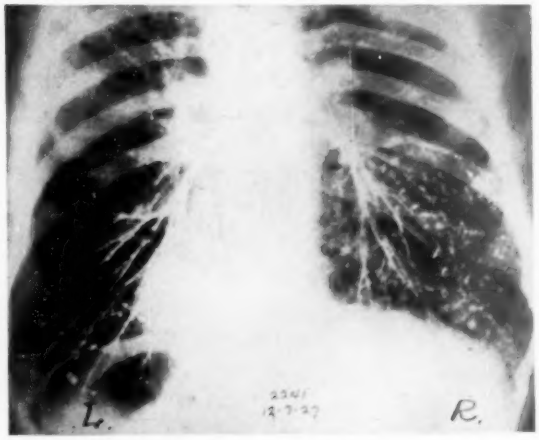


FIG. 4. Immediately following injection of lipiodol, the iodized oil descends to the finer bronchioles, but does not fill the terminal air vesicles. Note that the oil, first injected into the right side, has begun to extend out into the finer structures while that injected a few minutes later on the left side is still confined to the bronchial structure.

is quite simple: in the cadaver the oil cannot be injected beyond the smaller bronchial branches, so that they only are outlined in the roentgenogram; in the living the circulating blood absorbs the alveolar air and causes the oil to be drawn into the terminal air sacs giving the appearance of leaves on a tree.

These observations serve to explain the succession of roentgenological findings which occur after injection of the oil in the normal and pathological lung. Immedi-

ately after injection into the trachea in the normal lung, the opaque medium is seen outlining the smaller bronchial branches, but the alveolar structures are not yet filled. Serial roentgenographic examinations made at intervals of a few minutes will show the gradual descent of the oil into the distal portions of the lung, as the air in the terminal air sacs is absorbed, with the development of feathery clusters about the bronchioles (Figs. 4 and 5). Obviously, in the majority of instances, not all of the air cells communicating with a small bronchiole are filled with the iodized oil, since the amount of oil contained in a bronchiole is usually insufficient to supply the entire volume necessary to fill the alveolar structure which it supplies. This is perhaps a very good thing for the patient, since complete replacement would result in atelectasis of the entire area.

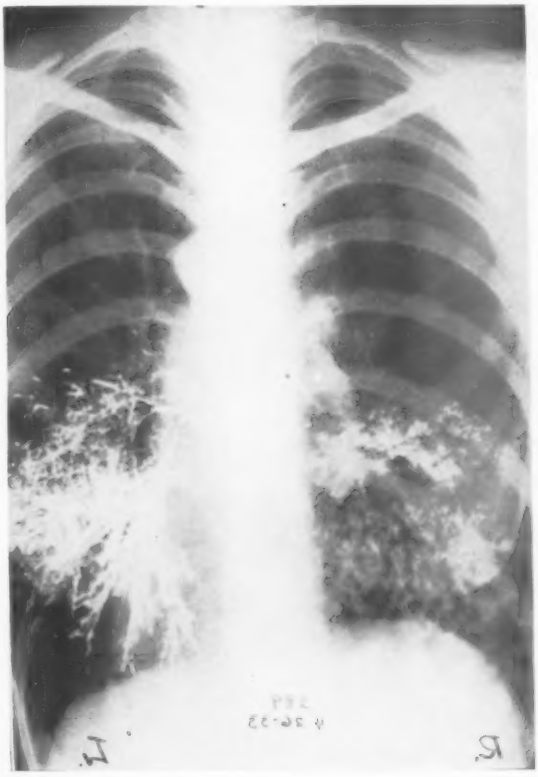


Fig. 5. Illustrating the succession of changes which takes place after injection of iodized oil. On the left side immediately after injection, the bronchi are still filled with the oil and there has been very little extension into the air vesicles; on the right side, injected one week previously, the bronchi are empty and all of the material has been drawn out into the alveolar structure.

The application of cocaine to the bronchial mucosa abolishes the cough reflex and seems to result in relaxation of tone of the bronchioles, causing them to dilate (Fig. 6). This in turn allows much larger reservoirs of oil to collect far back in the larger bronchial branches; under these conditions, extensive areas of the lung field may become drowned with the opaque medium. Roentgenologically such a condition defeats its own purpose; it not only obscures the characteristic features of normal lung structure, but may even give an impression of pathology where none exists (Fig. 7). Early in the use of lipiodol areas of drowned lung were frequently diagnosed as "abscesses" of the lung. If we are aware of these possibilities, and understand their explanation, we should not fall into error in diagnosis. It would seem, therefore, that conservative amounts of oil should be injected into each lung field under investigation in order not to drown the lung and obscure the finer lung structure, and that excessive cocainization of

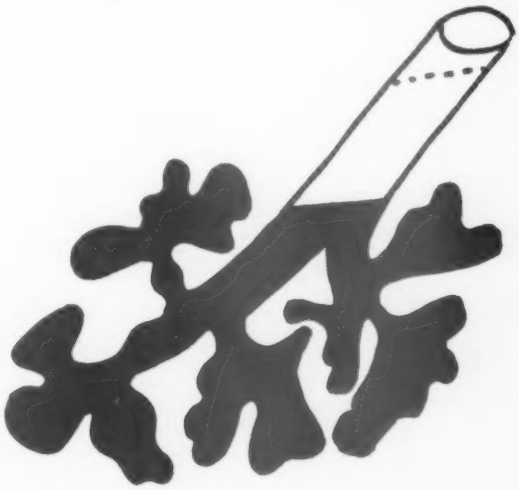


Fig. 6. Diagram of terminal respiratory unit showing increase in volume of oil produced by cocainization of bronchioles. This increase in volume of oil is sufficient to permit filling of a much greater number of terminal air vesicles.

the larger bronchial branches should not be resorted to during the procedure.

Once drawn into the terminal air sacs, the opaque oil remains unabsorbed for many months. After a long sojourn in the lung, lipiodol loses its characteristic appearance and a normal lung may acquire

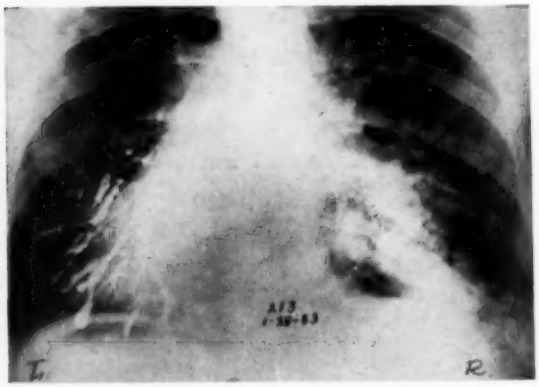


FIG. 7. Injection with an overdose of lipiodol, drowning the lung and giving the appearance of pathology on the right side where none is present. Such over injection has resulted in erroneous diagnosis of lung suppuration. Bronchietatic dilatation of the bronchi is noted on the left side behind the cardiac shadow.

the appearance of extensive tuberculous infiltration (Fig. 8). The simple epithelial lining of the terminal air sacs does not lend itself readily to absorption of this fatty material and its removal is largely by phagocytosis and lymphatic drainage through the hilar glands (Brown[3]). Is it not possible that prolonged contact of the alveoli with this oil may result in inflammatory changes, such as those seen where it is allowed to remain in prolonged contact with serous membrane such as pericardium, pleura, peritoneum and various joints? Is it not possible that some of the alveoli may be obliterated as a result of this inflammatory reaction?

Investigations made soon after injection reveals a mononuclear infiltration of the area, apparently endothelial in origin. Examination at this time fails to reveal any definite fibrosis; it may be possible, however, that prolonged contact may result in some permanent changes. Such a process could easily go on without clinical manifestations, since the elimination of small groups of alveoli here and there throughout the lung would be compensated for by compensatory emphysema of the remaining aerated portion of the lungs.

While the injection of iodized oil is relatively innocuous in this location, still it would seem advisable, on account of its long sojourn in the finer lung structure, to confine the examination to the immediate field under investigation, employing cocainization of the larynx only, never using local anesthesia in the finer lung structures except where absolutely necessary to control a hypersensitive cough reflex.

The simplest and easiest method of injection is the supraglottic method where the oil is injected through a short cannula on to the back of the tongue. Where the lower lobe bronchi alone are to be investigated and where the extent of the pathology is unknown, this method is quite satisfactory. By inclining the body of the patient to one side or the other, the oil may be directed into the base of either lung. This method has the disadvantage of not permitting roentgenoscopic observation during injection of the oil.

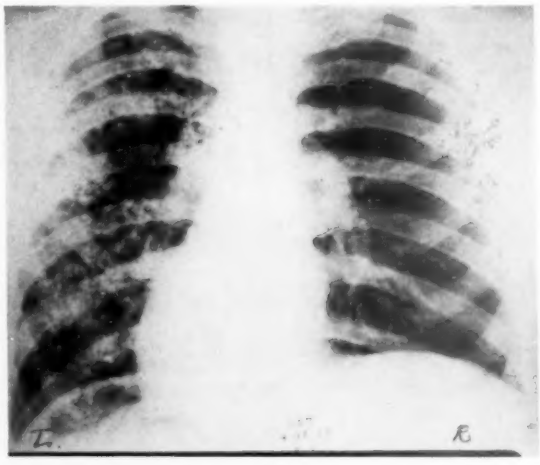


FIG. 8. Appearance of chest four months after receiving a large dose of lipiodol into the left side. The iodized oil loses its normal density because it is broken up into such fine particles, and the picture produced could easily be confused with extensive tuberculosis, whereas the lung is really normal.

The cricothyroid method, where the oil is injected through a needle inserted through the cricothyroid membrane, is not devoid of danger, and, while it will permit observation of the oil as it enters the trachea, no selection of the field is possible and from the roentgenologist's viewpoint it offers no advantage over the more convenient, safer supraglottic method. We have found it necessary to resort to this method only very rarely. In one instance, in spite of all precautions, the tracheal wall was penetrated and the oil was injected into the tissues of the neck. A straight needle should never be used for the injection; a curved needle which conforms to the contour of a tracheotomy tube is more satisfactory.

The most satisfactory method of injection from the roentgenologist's standpoint is through a catheter previously inserted into the trachea under local anesthesia (Fig. 9). This method has the great advantage of permitting roentgenoscopic observation during injection of the oil. If a Coudé catheter is used, with a single opening in the tip, the stream of oil may be directed in any direction by rotating the catheter with the fingers while in place.

The insertion of a catheter into the trachea is sometimes difficult for a roentgenologist unskilled in the use of the laryngeal mirror; the cooperation of the laryngologist to perform this function routinely may likewise be inconvenient and impractical. Any simple method, therefore, by which this can be accomplished would be acceptable to the roentgenologist.

The use of the direct laryngoscope is an exact and simple method, where the patient is under the influence of a general anesthetic but is sometimes difficult where local anesthesia alone is relied upon. One method which has not been especially stressed is the direct manual insertion of the catheter by the sense of touch in the same manner as employed for intratracheal insufflation anesthesia. After thorough laryngeal anesthesia the left index finger is inserted as far as possible, locating and gently holding the epiglottis forward. With the right hand a Coudé catheter is introduced, using the sense of touch to direct the tip of the catheter forward, in midline over the epiglottis. As the catheter slips beyond the glottis there may be a paroxysm of coughing which requires injection of a small amount of 1 per cent cocaine through the catheter. The catheter may tend to straighten out, making it impossible to make the curve around the epiglottis unless a stylet is used in the catheter.

Fig. 9. Injection of the oil under roentgenoscopic observation through a catheter inserted into the trachea limiting the examination to a small area gives much the most satisfactory result wherever possible. Note the catheter extending into the bronchus and the bronchiectatic area immediately below. Contrast with lipiodol in area of normal lung anteriorly.

If a silk catheter is used, it may be rendered less flexible by soaking in ice water before insertion. This will permit curving of the end of the catheter to allow its passing around the epiglottis.

Especially where there are large areas of atelectasis to be investigated the bronchoscopic method may be invaluable.

In children the process is even more difficult. The supraglottic injection cannot be carried out because of lack of cooperation of the patient. Likewise the injection by needle through the cricothyroid membrane is most difficult and dangerous. Perhaps the best method, where it can be carried out, is injection through a specially constructed intubation tube recommended by Iglauer.[6] In a perfectly alert, healthy child without its sensibilities blunted by toxicity from some constitutional disease, in whom there is no edema nor inflammation of the larynx, this may also be a very difficult procedure; some children can cough the tube out as fast as it is reinserted. Under certain conditions, this may be a satisfactory method of administering the oil; however, it does not permit its instillation into any particular location.

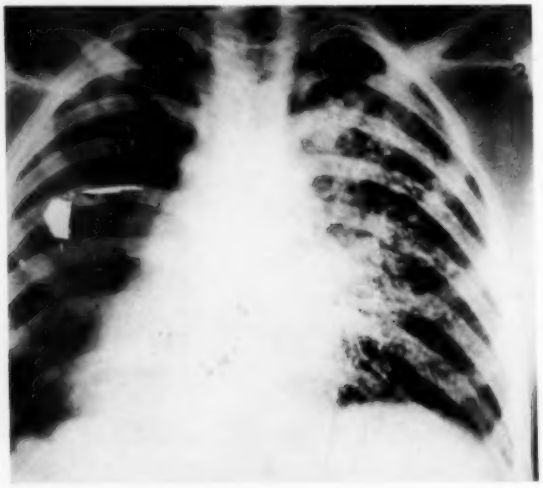


FIG. 10. Iodized oil aspirated into lung by instillation into nares of a nine year old boy during sleep, suggesting close relationship between chronic sinus infection and subsequent development of lung infection. Lung filling is possible in children by this method, but the area covered is much greater than is recommended.

A simple method, which at times proves effective in young children, is the direct instillation of the oil into the nostril or, more conveniently, into a nasal tube passed into the posterior nares during sleep, natural or induced by avertin (Fig. 10). In order to direct the oil into the proper location in the base of the lungs the patient must be in a bed equipped with an adjustable head rest. The patient must be rolled on one side or the other to direct the oil into the base of either lung. It is possible to secure satisfactory filling in this manner although at times the oil may be too widespread in its distribution. A more satisfactory method if it works in children is to pass a small caliber Coudé catheter through the nose; in a number of instances this will enter the larynx without other manipulation. It this can be done, it offers the best method of examination in children.

REFERENCES

1. BLOCH, R. G. The viscosity of lipiodol in bronchography. AM. J. ROENTGENOL. & RAD. THERAPY, 1932, *27*, 847–852.
2. BONNAMOUR, S., and BADOLLE, A. The roentgenography of the normal lung following injection of lipiodol, and the diagnosis of small bronchial dilatations. *Presse méd.*, 1929, *37*, 173–176.
3. BROWN, A. L. The fate of iodized oil (lipiodol) in the lungs. *Surg., Gynec. & Obst.*, 1928, *46*, 597–601.
4. BURMAN, M. S., TUNICK, I. S., and POMERANZ, M. The injection of lipiodol into the knee joint; a warning against its use. AM. J. ROENTGENOL. & RAD. THERAPY, 1932, *28*, 787–795.
5. CRANDALL, L. A., and WALSH, E. L. The effect of iodized oils on serous membranes. *Radiology*, 1929, *12*, 499–504.
6. IGLAUER, S. The use of iodized oil in the diagnosis of pulmonary lesions. *Surg., Gynec. & Obst.*, 1927, *45*, 82–87.
7. LASH, A. F. Lipiodol pelvic cysts. *Surg., Gynec. & Obst.*, 1930, *51*, 55–60.

Vol. XXXII, No. 6

THE PRESENT STATUS OF THE DIAGNOSIS OF RENAL TUMORS*

By B. H. NICHOLS, M.D.
Cleveland Clinic
CLEVELAND, OHIO

WHEN one considers the high rate of mortality associated with renal tumors and the advanced stage of their development before a diagnosis is made, and that metastatic lesions are often the first sign of the disease, one is at once impressed with the importance of any new diagnostic developments in this field. A correlation of such information has been my aim in this presentation.

First of all, it is assumed that at the present time a roentgenologist undertaking the examination of a patient suspected of having a renal tumor is a capable clinician who is familiar with the history, symptoms and course of such lesions, together with the morphology, pathology and possibilities of behavior at any stage of their course and also with the pathologic conditions of the kidney and surrounding areas which must be taken into consideration in making a differential diagnosis. Many times by a process of elimination of possible causes of the symptoms a diagnosis of renal tumor may be made when a direct attempt at making such a diagnosis would fail.

The recent developments in the diagnosis of kidney tumors reported in the literature have been rather limited to case reports and to the emphasis of complications encountered accompanying such lesions. I have attempted to abstract from these reports such information as may be of aid to the roentgenologist in reporting his findings.

In summing up a paper on "Tumors of the Renal Pelvis," MacKenzie and Ratner[13] conclude:

> The disease is very often wrongly diagnosed and the diagnosis must be made from the history, symptoms, urinary findings, cystoscopic and pyelographic findings.

In the past many roentgenologists have been content to confine their diagnostic contribution solely to the field of roentgenology, anticipating that all other clinical help would come from the urologist. This has been a quite satisfactory arrangement since the urologist was usually the one who referred the patient and the only one capable of cystoscopic examination, catheterization of the ureters, and injection of the kidney pelvis before a pyelographic examination could be made. But with the newer development of excretion urography the roentgenologist has added responsibilities, for many patients are referred direct to him.

Many times all the information obtainable after such an examination will not be sufficient to solve the problem, but in such cases the fact that the patient has a definite kidney lesion can usually be determined and he can then be referred to a urologist for further examination.

The status of excretion urography in the diagnosis of renal neoplasm should be carefully considered. The situation of most palpable masses in the region of the kidney may easily be determined to be outside the kidney by an excretory urogram which usually shows clearly that the kidney pelvis and kidney are extrinsic to the palpable mass. The diagnosis may become difficult in the case of a tumor arising from the capsule or of a perirenal tumor attached to the kidney, and if there is no deformity of the pelvis neither excretory nor retrograde pyelography will be of much diagnostic value except in a negative way. Excretory urography often shows characteristic distortion of the pelvis and calyces in tumors of the kidney proper, together with a fair estimate of function in such a kidney.

* Read before the American Congress of Radiology, Chicago, Ill., Sept. 25–30, 1933.

Recently in a paper on renal tumors Wade[24] has stated:

My theme in brief may be stated to be based essentially on the relative rôles of infusion and excretion urography. Infusion urography indicates form. Excretion urography indicates function. The former is the primary diagnostic aid for the recognition of the presence of a tumor of the kidney. The latter, by indicating the state of the adjacent renal parenchyma, is a valuable aid in identifying the type of growth that is present.

This knowledge not only permits of a more accurate preoperative prognosis but also thereby gives warning of some of the complications that may be met. Of these the most important are: the daughter tumor concealed in the ureter in a villous papilloma of the renal pelvis; the accessory venous circulation in the perinephric fascia due to a neoplastic thrombus in the renal vein in cases of hypernephroma or papillary carcinoma; the involvement of the renal pedicle and the adjacent lymph glands in cases of alveolar carcinoma.

In other types of tumor, such as the epidermoid carcinoma and the embryonal carcinoma, and the rare tumors, information of similar value is also obtained. It amounts to this: 'The degree of malignancy of a tumor of the kidney is in inverse proportion to the functional activity of the organ as a whole.'

In the discussion of this paper Dr. Braasch stated:

My experience coincides to a very large degree with that of Mr. Wade as to the value of intravenous or excretory urography in the differential diagnosis of renal tumor. I will say, however, that if we relied upon the intravenous urography entirely, we would frequently find ourselves in difficulty. It may be quite misleading.

I agree with Mr. Wade that unless a man is skilled in the diagnosis and interpretation of pyelography, he should not attempt to employ intravenous urography. Unless the details of the pelvic deformity are clearly visualized, interpretation may be frequently misleading. I have observed a number of intravenous urograms in which we might infer that we are dealing with a normal pelvis, where neoplasm was found to be present when the retrograde method of pyelography was employed.

Secondary infection or reflex irritation may affect the degree of visualization with intravenous urography, so that great care must be employed in its interpretation. The two methods of intravenous and retrograde urography are often very valuable when combined. Very often intravenous urography is distinctly better than the retrograde method, when there is obstruction at the ureteropelvic juncture or retention of urine in the pelvis.

Excretion urography has become one of the most important advances in roentgenology, not even surpassed by cholecystography. An excretory urogram may be safely done and all the necessary evidence found for the diagnosis of a renal neoplasm in most cases. Further examination by a retrograde pyelogram if catheterization of the ureter is possible may give much added information and should always be resorted to in all cases where there is any doubt about the diagnosis.

Careful attention to the technique of the latter examination is necessary. Wilson[26] in an excellent paper on the diagnosis of renal tumors warns against a mistaken diagnosis in an incompletely filled pelvis. This may come about either by failing to insert the catheter high enough, with a consequent reflux into the bladder, or by attempting to fill a kidney pelvis with an opaque medium, when it is already full of retained urine or blood clots. This pitfall may be obviated by draining the pelvis before a pyelogram is attempted and by repetition of the examination when there has been any question of the cause of a filling defect in the kidney pelvis.

Within the last decade another method of roentgenographic diagnosis of the kidney has received considerable mention in the literature, namely, pneumopyelography. All roentgenologists should be familiar with the advantages and disadvantages of this method.

Thompson[23] in 1922 wrote:

. . . The injection of gas into the renal pelvis for roentgenologic purposes has not been popularized to the extent that it deserves, . . . the technique of which is simple and the advantages numerous. . . . The injection of oxygen into

the ureter or renal pelvis causes no shadow at all but creates a space which shows up black on the x-ray plate, and brings into relief not only the pelvis and calices, but also the kidney tissue, as it does not obscure the shadows caused by the tissues either in front or behind. For instance, the shadow of a stone in the ureter, pelvis or calix will not be obscured by the oxygen and the size, shape and position of the stone can be easily determined. . . . So far in our group of cases only oxygen has been used in pneumopyelography which meets fully the requirements of a contrasting media, in that it is not toxic and not irritating and may even be beneficial in some cases. As oxygen is more permeable than any of the opaque solutions, it will pass obstructions or constrictions more readily than the solutions.

The author then describes his technique of examination, and illustrates one case of stone with hydronephrosis, the stone not having been demonstrated by pyelogram with an opaque medium, and concludes:

1. Pneumopyelography is a simple, though uncommon, procedure and deserves a greater popularity.

2. This procedure is attended by apparently no reaction and causes the patient less discomfort than the injection of an opaque solution.

3. In certain cases it is a greater aid in roentgenographic diagnosis, than the opaque solutions.

Neuwirt[18] has stated that he regards this procedure as the method of choice in the diagnosis of nephrolithiasis.

It will disclose the smallest stones more often and better than pyelography alone. Even simple incrustations stand out very clearly. Furthermore, one examination suffices to obtain all the information needed. The author has found it to be the only method which made possible a diagnosis of a tumor of the kidney pelvis or of the ureter. In cases of tumor of the kidney parenchyma, pyelography is the method of choice. Bleeding from the pelvis of the kidney is not a contraindication to the method.

Chauvin, Empéraire, and Esmenard[2] advise the injection of air under a constant manometric water pressure of 80 cm. They claim that it is painless and safe as it allows of a wide margin of safety from any possibility of air embolism. They say:

The especial value of the method lies in the exact localization of calculi, and in the demonstration of those of little density, when an opaque medium merely conceals; further, papillomata of the renal pelvis are shown, and large hydronephroses may be filled with impunity.

Tasker in an abstract of an article by Bedrna and Simon[1] states:

The author discusses the difficulty in the diagnosis of tumors of the renal pelvis from other causes of unilateral renal hemorrhage. Ordinary pyelography may show large tumors as a filling defect, but small papillomata are likely to be hidden by the shadow of the opaque fluid. When small tumors of the renal pelvis are suspected he advises pneumopyelography. Ordinary atmospheric air is injected by a 20 c.c. syringe into the renal pelvis through a small ureteric catheter, the injection being made slowly. In 345 cases no complications followed.

A difficulty in diagnosis by this method is blood-clot in the pelvis, as the shadow from the x-ray may resemble a papilloma. For this reason repetition of the pneumopyelography is advised after some days. If the shadow has not altered, a tumor is probable, but if due to blood-clot then the shadow will have altered or disappeared. Details of two cases are given in which this method enabled a correct diagnosis to be made.

Jeck[8] has reported a case of air embolism which proved fatal. This was the only death in his six years' experience with inflation of the bladder in cases of suprapubic cystotomy.

Mathé[16] reported a case of fatal air embolism from inflation of the bladder. The patient was a man, aged fifty-six, with hypertrophy of the prostate, chronic retention, an ulcerated bladder neck and a papillomatous growth on the base of the bladder about 4 cm. in diameter. A suprapubic approach was decided upon and the bladder was inflated with 300 c.c. of air. After a few seconds, and while the first sutures were being taken in the fundus, a hissing sound in the bladder was heard. The patient became cyanotic, the eyes fixed, the pupils dilated, and the pulse and respiration suddenly ceased. All attempts

at resuscitation were futile. At necropsy, air was found in the iliac and mesenteric vessels, the vena cava and the renal veins. The lungs, liver and the right chambers of the heart contained coarse frothy air. Following this fatal accident, Mathé made an extensive investigation of the problem during which time he sent out 2,050 questionnaires to surgeons doing genito-urinary surgery in this country and abroad and received 791 replies. In 25,890 inflations with air, there were 34 cases of air emboli. He states that air under pressure in the normal bladder and ureter causes no harm, but says,

> The formation of emboli takes place by the entrance of air into the venous circulation either through an ulceration of the mucosa caused by some pre-existing pathologic lesion such as an ulcer, a tumor, a deeply congested area due to cystitis, etc., or through a laceration of the mucosa caused by over-distention of the bladder. . . . Once the veins of the bladder wall are ruptured, a minimum amount of pressure can cause penetration of air into the vesical veins and thence into the vena cava and right heart.

Lewis'[11] theory is that the air enters into the circulation by way of the pelvis of the kidney after having regurgitated through the ureter. Santini's[20] experiments did not support this theory. He injected air under considerable pressure into the healthy bladders of dogs and found that the healthy bladder invariably ruptured before air would enter the kidney pelvis through the ureter. When he injected air into the abdominal portion of the ureter, he found that air could be introduced into the circulation by way of the renal parenchyma. Piddighe,[19] experimenting with 11 dogs, could not support the latter part of Santini's work. He injected air into the lumen of the ureter under considerable pressure for from fifteen to thirty minutes. This caused considerable increase in the volume of the kidney but death from air emboli could not be produced. Subsequent autopsies showed considerable dilatation of the pelvis and tubules, but in no case was he able to demonstrate air in the circulation. However, when the veins of the bladder wall were traumatized, inflation of the bladder with air under low pressure caused death in a few minutes. In these dogs, at necropsy, the usual pathologic picture of air emboli was found.

Mathé concludes:

> Rupture of the vesical mucosa by over-distension, or the presence of a pre-existing pathologic lesion such as marked inflammation, ulcer formation, or a new growth weaken the bladder wall thus favoring the entrance of air into the venous circulation.

This is a very excellent and comprehensive study of air emboli and includes a long bibliography. It includes a summary of 23 collected cases of air emboli with 18 deaths.

We are doing an increasing number of pneumopyelograms, particularly in cases in which pelvic papillomatous tumors are suspected. These have been performed with no discomfort to the patient. Our feeling is that if the catheter is not tightly gripped in the ureter, as occurs in case of a stricture or ureteral stone, there is little danger of creating a pressure in the kidney that would be at all hazardous, as the air will reflux into the bladder when the pelvis is filled. Roentgenograms are made while the air is being injected. This method of examination has some very distinct advantages in the diagnosis of pelvic tumors or kidney stones.

Pyeloscopy is another technique for the examination of the kidney which has been used by some workers for many years, but has not received widespread attention in the field of renal diagnosis. An excellent article by Herbst[6] outlines its particular sphere of usefulness and a statement which he quotes from Jona and Flecker would seem to have an important bearing on the diagnosis of tumors. They found that atropine definitely decreased the activity and produced relaxation of the pelvis to the point of painful distention which was in turn relieved by the administration of eserine. It seems reasonable that in cases

in which function is not a consideration, or after the determination of function by excretory urography, repetition after the administration of atropine might better outline the deformity of the kidney caused by a renal tumor.

In another article by Manges,[14] who introduced the pyeloscopic method in 1912, and who has had a long experience with it, its advantages in the diagnosis of renal tumors are outlined as follows:

> The fourth advantage comes in being able to palpate the movable kidney, and at the same time, see what the effect of palpation or manipulation is in the matter of rotating the kidney or determining the extent of its mobility. . . . One also palpates tumor masses that are present in the abdomen and in this manner can determine very definitely whether the mass is attached to or a part of the kidney, even when there is not deformity of the pelvis and calices due to the involvement of the tumor.

The ambition of most clinicians is an attempt to determine the type of tumor with which they are dealing. This, of course, would be ideal but a glance at the great mass of controversial literature on the classification of renal neoplasms makes it an impossibility for all practical purposes at the present time. If the pathologists cannot agree on the type of tumor after examination of the sections, how much more difficult is it for the clinician and roentgenologist to determine the specific type of lesion? If one can determine the presence or absence of a kidney tumor along with a fairly accurate estimate of whether it is malignant or benign, an admirable service has been rendered to the patient and to the surgeon.

A recent article by Gottesman, Perla and Elson[4] illustrates the difficulties encountered in the diagnosis of specific tumors. They reported the pathologic findings in 44 cases of hypernephroma. Sixteen of these were found by chance at autopsy. Some of the specimens showed all gradations from benign structure to malignant hypernephroma in the same tumor. Cortical adenoma, typical hypernephroma, papillary and adenomatous malignant areas, and also carcinomatous and sarcomatous-like infiltrations were observed.

There apparently is no classification of renal tumors to which all are agreed. Graham[5] disposes of this subject in a practical manner:

> Comparative statistics concerning the incidence of the various types of renal neoplasms is increasingly difficult to obtain from the numerous clinics where comparatively large numbers of these cases are treated. This is due chiefly to differences in the interpretation of the two most frequently encountered types of neoplasms, namely, hypernephroma and carcinoma. It is not surprising, therefore, that in one clinic about 80 per cent of all malignant renal neoplasms may be classified as hypernephromata, and in another clinic less than 30 per cent are so classified. It is highly improbable that the Grawitzian tumor is less prevalent today than it was twenty-five years ago.

Hypernephroma.—The type of lesion described by Grawitz is the most frequently encountered, and, therefore, is the most important neoplasm of the kidney. That it originates in adrenal cortical tissue, which is included in the kidney during its developmental period, has been disputed recently. Whatever may be the final judgment in the matter, segregation of this group of tumors seems amply justified by embryological, gross, microscopical, chemical and clinical considerations.

Carcinoma.—Second in order of frequency and importance among renal neoplasms are the carcinomata, which may be considered under two groups: (*a*) those arising from tubular or glandular epithelium, and (*b*) those arising from the pelvic mucosa.

(*a*) Probably the most important source of carcinomata in the substance of the kidney in adults is the adenoma, occurring with comparative frequency.

When the adenoma becomes malignant (carcinoma), fairly well circumscribed or diffusely infiltrating neoplasms of considerable size may result. Clinical manifestations (pain, hematuria, palpable tumor), anatomical alterations, and abnormalities noted in roentgenograms and pyelograms naturally depend upon the location, size, and rate of growth of the tumor, and whether or not the pelvis is secondarily involved.

(*b*) Carcinomata arising in the renal pelvis are of two types—papillomatous and epidermoid.

Sarcoma.—True sarcoma in the sense of a malignant tumor arising from the supporting tissue (capsule, stroma, or adventitia of blood or lymph vessels) is rarely observed in the kidney as a primary tumor. A rather hurried search of the records of the Cleveland Clinic for the past eight years has failed to disclose a single case. It is more than probable that a large percentage of cases appearing in the literature under the heading of sarcoma would be more appropriately classified as cases of embryonal carcinoma or of mixed tumor of one type or another.

Mixed tumors.—Mixed tumors constitute the third group of renal neoplasms in order of frequency and importance. They are not a homogeneous group and do not conform to a type. In this group are included tumors which are probably variable in derivation, and certainly variable in composition. The one feature that characterizes them as a group is the fact that they comprise the majority of renal neoplasms which occur in childhood.

Extra-renal tumors.—Lipomata may develop in the peripelvic fat of normal kidneys and result in displacement of the organ and deformity of the pelvis. They may develop in the fat which is deposited in kidneys that are atrophic as a result of interference with the circulation or as a result of chronic infection, with or without calculus, or they may develop in the perirenal fatty capsule and by their size misplace an otherwise normal kidney.

Fibromata, *fibrolipomata*, or *fibromyxomata* may develop in the perirenal tissue. The myxomata may either be encapsulated or diffuse and may become sarcomatous. These tumors may displace, but usually do not invade, the kidney.

Retroperitoneal neoplasms such as lymphoblastoma, common sarcoma, endothelioma, and tumors of the adrenal may simulate renal neoplasms.

Subhepatic, *intrahepatic*, *subdiaphragmatic*, or *psoas abscesses* and *omental* and *mesenteric cysts* may simulate cystic tumors of the kidney.

I use Ewing's[3] classification of tumors of the renal pelvis which meets the need of the roentgenologist for it is convenient and workable.

Papilloma. These are usually multiple and large papillomas may be surrounded by smaller ones. Papillomas may be associated with calculi. Papillomas are very vascular tumors and bleed easily. They are usually benign, but tend to become malignant and give rise to transplants along the ureter and in the bladder. They constitute about 50 per cent of the pelvic tumors of the kidney.

Papillary Epitheliomas. These are wart-like growths, which in the early stage involve the submucosa, but later extend into the renal parenchyma. Late stages of the growth may be accompanied by cortical cysts. These are very vascular tumors and hemorrhage is frequent. Papillary epithelioma makes up about 20 to 30 per cent of kidney pelvic tumors.

Alveolar Carcinoma. These are probably late papillomatous growths which have lost their papillomatous formation and form scirrhous type of growths. These are large tumors, have a high degree of malignancy, and metastasize widely.

Squamous Cell Carcinoma. This type of tumor forms a very small group. They are characterized by rapid growth, extensive metastases, infiltration of the surrounding tissues and kidney parenchyma, and rapid fatal termination.

Since the pathologists themselves have such difficulty in making an exact diagnosis in cases of kidney tumor, the roentgenologist cannot hope to report a specific type of tumor in a given case with any high degree of accuracy. And there are always certain cases in which some doubt remains even after the most careful clinical, roentgenologic and pathologic study, and it is literally impossible to make any accurate predictions regarding the final outcome.

The following cases will serve to emphasize some of the difficulties of diagnosis, and the necessity of giving a guarded prognosis even though the histopathology of a given tumor is indicative of a relatively hopeful outcome:

CASE 1. A woman, aged fifty-four, was referred to me for examination by Dr. W. E.

Lower, on July 29, 1929. Her chief complaint was "weakness and fullness in the stomach." In January, 1929, she had influenza, and about this time had developed a frequency and burning on urination. She had become quite constipated, and had lost 40 pounds.

When she presented herself for treatment, there was a large mass in the left hypochondrium which extended to the crest of the ilium and across the midline into the right side of the abdomen. The clinical impression was that this mass was caused either by an enlarged spleen or left kidney. The renal function as determined by the phenolphthalein test was 70 per cent. The cystoscopic examination disclosed no abnormality, but urine specimens from both kidneys contained a moderate number of pus cells. The roentgenogram of the kidneys, ureters and bladder showed a large mass in the left kidney region which appeared to be extrarenal. The pyelogram showed hydronephrosis, and displacement of the ureter and the kidney beyond the right of the midline by a large mass. The pyelographic diagnosis was a probable tumor of the left kidney.

Operation was performed by Dr. Lower on August 14, 1929. A large mass measuring about 11×15 cm. was attached to the kidney. Visible renal tissue appeared grossly normal. The tumor surrounded and included the left kidney. The kidney was easily removed from the mass, leaving a well-formed depression. Toward the upper pole of the kidney, lying outside of the well-encapsulated main portion of the tumor, was a mass of fat tissue which was not encapsulated and had a consistency that suggested the possibility of myxomatous change. The blood supply of the whole myxomatous mass was not very abundant. Fetal lobulation persisted. One microscopic section was made up of myxomatous tissue. There was a fibrous capsule and external to this was a small amount of fat. Histologically it did not appear to be very malignant. Another section was made up of fibromyxomatous tissue, the fibrous predominating; a small amount of fat was scattered through the sections which histologically appeared benign. The diagnosis was perirenal myxoma.

This patient returned again to the Clinic, on September 11, 1933, with a recurrent, extensive, inoperable mass which practically filled the entire abdomen and probably involved the intestines. The chest roentgenogram showed no evidence of metastases.

This represents one of a group of tumors which are potentially malignant in that they recur locally but do not give rise to distant metastases.

Case II. This patient was a man aged fifty-four, first observed in November, 1923, who complained that he had had a nervous breakdown six months previously, and that he felt below par on arising in the morning. During the day he felt well. He also complained of vague gastrointestinal disturbances which seemed to be associated with his nervousness. There were no genitourinary symptoms except that he had had one sharp attack of back pain sometime previously which had gradually disappeared and had not recurred. The physical and laboratory examinations gave no clue to his complaints and his hemoglobin was 90 per cent. He was reassured and advised to get additional rest in the belief that the condition was one of neurotic origin.

He returned again in August, 1927, stating that his endurance was poor and that he had had another attack of back pain during the previous year which had gradually improved and was then absent. Since this last attack of pain his appetite had been poor. He had nocturia, three times each night.

Physical examination showed nothing of significance except for a few pulpless teeth. The roentgenograms of the kidneys, ureter and bladder and of the lumbosacral region showed no abnormality. Cystoscopic examination revealed a mild trigonitis and slight prostatic hypertrophy. Since there was no clinical indication for a pyelogram, this examination was not done. Because of the vague symptoms of pain, gastric disturbances, listlessness, irritability, and his changed mental outlook, it was thought that the problem was chiefly a neurologic one.

He sought treatment again in November, 1927. At that time he had ascites and the liver was enlarged. The kidneys were not palpable and there had been no urinary symptoms except the frequency and nocturia. Exploration was resorted to and an inoperable tumor of the kidney was found. The operative diagnosis was hypernephroma of the right kidney.

This is a representative case in which the clinical history, vague symptoms and negative physical examinations certainly were not suggestive of a malignant con-

dition, especially of the kidney. This patient developed metastases and ascites before such a lesion was suspected. Renal malignancies with such a history will probably be overlooked, unless a pyelographic examination is adopted routinely, which, most will agree, is impracticable. It also illustrates that a normal roentgen picture of the kidneys, ureters and bladder does not eliminate the possibility of a renal tumor.

CASE III. The patient, a physician, aged sixty-eight, had an unexplained fever which was intermittent and recurrent, sometimes rising as high as 101.5° F. He had examined his urine and had found some pus and albumin. He had some burning on urination and some difficulty in starting his stream. He did not feel unwell. He attributed the fever to infected tonsils. Physical examination revealed a right upper abdominal mass which extended to the level of the umbilicus, and chronic prostatitis. The urine examination showed no significant abnormality except an occasional red blood cell in one of numerous specimens. The Wassermann and Kahn tests were positive. Syphilis had been contracted years previously during an operation on a luetic patient. The pyrexia, the abdominal mass, which was interpreted from palpation as being the liver, and the positive reaction of serologic tests led to the diagnosis of luetic hepatitis. He was given antiluetic treatment. Six months later an excretion urogram was made for renal function incident to a prostatic punch operation, and a large deformity of the right kidney was noted; this was interpreted as being due either to an anomalous kidney or to a tumor. A pyelogram was made and this showed, with greater detail, a very large deformity of the right kidney which was interpreted as a hypernephroma.

At operation an inoperable malignancy of the kidney was found which had invaded the perirenal tissues. The operative diagnosis was hypernephroma. The patient died five months later.

This case serves to illustrate the caution which one must exercise in forming any conclusions, from palpation alone, as to the origin and nature of abdominal masses. Only one of the so-called cardinal symptoms of renal malignancy was present, and its association with an infectious process which might produce enlargement of the liver, resulted in misinterpretation of the signs and symptoms.

In connection with these cases which have presented especially puzzling diagnostic problems, I am presenting the data which have accumulated in the study of a series of cases of renal tumor seen at the Cleveland Clinic.

In 100 proved cases of kidney tumor there were 55 hypernephromata, 20 carcinomas, 3 squamous cell carcinomas of the renal pelvis, 16 kidney tumors in children, 3 cases of fibromyxosarcoma, 2 of perirenal myxoma, and 1 sarcoma. The symptoms in their order of frequency were pain, a palpable mass and hematuria. All of these symptoms were present in 25 per cent of the cases. Of the patients with hypernephroma, 55 per cent had hematuria, 28.3 per cent of these without pain.

The clinical impression included kidney tumor in 80 per cent. In 20 per cent involvement of the genitourinary tract was not suggested by the symptoms. The plain stereoscopic roentgenogram revealed a diseased kidney and raised the question of tumor in 75 per cent of the cases of hypernephroma, in 30 per cent of cases of carcinoma and in 50 per cent of the childhood tumors. The cystoscopic examination revealed little information in cases of hypernephroma except when blood was seen to come from the ureter. In the cases of carcinoma of the kidneys, 15.4 per cent showed transplants to the bladder. Pyelography yielded a correct diagnosis of tumor in 64 per cent of the total series and in 83 per cent of all cases in which a carcinoma was present. Excretion urography was used in only a small group of cases of kidney tumor but revealed the lesion in all instances in which it was employed.

Some recent cases culled from the literature and some additional reports from our own series serve to illustrate further some of the more rarely encountered complications and features of roentgenographic diagnosis of kidney neoplasms.

Meredith[17] has reported a case of kidney tumor complicated with a tuberculous infection. This patient had a papilloma of the kidney with transplants to the ureter and bladder accompanied by a tuberculous infection in the same kidney. Cystoscopic examination showed a papilloma of the bladder, and this, with the finding of acid-fast bacilli in the urine from this kidney, aided materially in making the correct diagnosis.

Kretschmer[10] reported a fibroma of the kidney in a man, aged thirty-eight. His chief complaint was painless and symptomless hematuria. Six years before, he had passed gross blood in the urine, followed one week later by severe pain over both kidneys and two months later he had passed a stone. The kidneys were not palpable. The physical and laboratory findings were normal, and the roentgenographic and cystoscopic examinations showed no abnormality. The right pyelogram showed a filling defect compatible with tumor. A diagnosis of a tumor of the right kidney was made and nephrectomy was performed. The kidney specimen was of about normal size. The pelvis was distended by a compact form, a grayish-white tumor 43 by 41 by 35 mm., which was attached loosely close to the large renal vessels at the root of the kidney, and all around the tumor there was peripelvic fat. There was very little compression of the renal substance by the tumor. Histologic examination showed the growth to be a fibroblastoma.

Kretschmer states that small fibromata under the capsule, in the cortex, or in the medulla at the bases of the pyramids are not infrequently found at autopsy but that they seldom cause signs or symptoms during life. "Large renal fibromata are also extremely rare and on account of their rarity they may be considered curiosities both from a clinical and pathological standpoint." He states that there have been only 11 cases of pure renal fibromata. Several theories are advanced to explain the etiology of these tumors. Ewing believes these fibromata have their origin in disturbances of development but quotes Genewein who thinks that they are not true neoplasms but are tumor-like nodules arising from superfluous tissue. They may occur in any part of the kidney. Symptoms consist of a palpable mass, pain and hematuria. They vary considerably in size, even to filling the abdomen. The prognosis in such cases is good.

Mackey,[14] in 1930, reported a case of hemangioma and considered the whole problem by means of a thorough review of the literature. He stated:

> Haemangioma of the kidney is of relatively rare occurrence, and authors of wide experience frequently report only a single new case. Infrequent though it may be, it is a condition of surgical importance, for it appears that a large proportion of cases ultimately demand operation more or less urgently. In the cases published, an accurate preoperative diagnosis has seldom been made.

McKenzie and Hawthorne[12] reported 2 cases of renal hemangioma in 1931. The first patient was a man, aged thirty-five, whose complaints were hematuria of ten days' duration, slight attack of pain in the left lower quadrant of the abdomen, and general weakness for two weeks preceding admission. There were no areas of abdominal tenderness and no masses were palpable. Both kidney areas seemed normal by palpation, and the cystoscopic findings were essentially normal. The urine contained red blood cells and a few pus cells. A pyelogram of the left kidney showed a dilated renal pelvis with distorted, irregularly placed and shaped calyces at the level of the second and third lumbar vertebrae. A left nephrectomy was performed. There was a moderate amount of perirenal infiltration and the cut surface of the kidney showed hemorrhagic areas just beneath the mucous membrane of the upper calyx. The kidney showed fetal lobulation; the cut section showed a dark hemorrhagic area at the upper pole, which was made up of larger and smaller blood channels, lined with endothelial cells and

containing red blood cells. Between these channels there was a fibrous connective tissue. The patient was well seven years later at the time the report was made.

The second patient, a man, aged thirty, complained of hematuria and pain in the left groin and burning on urination. He had had one attack of hematuria eight years before which had cleared up within several days not to recur again until ten days before his admission. There was tenderness on the left side about half way between the umbilicus and the anterior superior iliac spine. There were no kidney masses or tenderness. The voided specimen of urine contained blood cells. Cystoscopic examination showed that the left ureter was discharging blood. A pyelogram showed a markedly flattened middle calyx. A left nephrectomy was performed. At operation there was a marked adherent portion about the center of the kidney on the dorsal surface, the size of a silver dollar. There was also some depression and discoloration. In the medulla, near the pelvis, there was a reddish hemorrhagic area, which histologically consisted of larger and smaller closely packed dilated venous sinuses, filled with blood. Sections of the retracted areas showed what appeared to be an infarction, with collapse of the parenchyma, distorted blood channels and cellular infiltration and fibrosis. The diagnosis was cavernous hemangioma.

Hemangioma of the kidney is rare, is usually single but may be multiple. These may be situated in the pelvis, medulla, or cortex although they are seldom observed in the cortex. Pathologic study of these specimens show them to be composed of large cavernous sinuses lined with endothelium and filled with blood. Hematuria is the only constant symptom and injury may play a part in its onset. Clinical symptoms arise from hemorrhage and are due to ulceration into the pelvis of the thin-walled vessels. Preoperative diagnoses are seldom made. Many cases were considered as essential hematuria. Jacobs and Rosenberg,[7] also Jenkins and Drennan,[9] claim that the pyelogram presents a mottled appearance due to the permeation by the pyelographic medium of the angiomatous spaces, and the interpretation is difficult because of blood clots in the pelvis.

Renal stones, by reason of chronic irritation, are said to be provocative agents in the etiology of cancer of the kidney pelvis. Martin and Mertz[15] collected 108 cases of renal malignancy associated with renal stones. The average duration of symptoms of carcinoma was five months in this series of cases. Squamous cell carcinomas are said to be associated with kidney stones quite frequently. Scholl and Foulds[22] in 1925 reported 5 cases of squamous cell carcinoma of the renal pelvis, 4 of which were associated with renal stones. One of these patients gave a history of intermittent kidney colic and hematuria for twelve years preceding the cancer. Wells[25] collected 11 cases in 1922, six of which were associated with urinary stones. Scholl[21] reported 2 additional cases in 1933. These cases will be abstracted briefly. A woman, aged fifty-seven, had had kidney stones for seven years. The left kidney was removed and showed a squamous cell carcinoma. The kidney contained many small tumors and many large nodules, measuring 3 to 4 cm. in diameter. This patient died two months later with metastases to the lungs, liver, pancreas and retroperitoneal lymph nodes. The right suprarenal gland had been replaced by the tumor. Scholl's second patient was a woman, aged sixty-seven, who had suffered from thyroid disease since the age of twelve. For two years before admission she had noticed a gradually enlarging mass in her left abdomen which was associated with pain. Physical examination revealed a large palpable mass in the left abdomen and the roentgenogram showed stones and a large calcified mass in the lower kidney pole. An attempted pyelogram showed the iodide solution interrupted at the calcific area near the lower edge of the mass. Operation was performed and the kidney contained pus and stones. There was a

squamous cell carcinoma of the renal pelvis which had extended into the surrounding structures too extensively to be removed.

The prognosis in cases of squamous cell tumor is poor. Four of the 5 patients reported by Scholl and Foulds died during the first four months, and one was alive six months after operation. Metastases develop early and extensively and the condition is rapidly fatal.

In the Cleveland Clinic series of 23 confirmed cases of carcinoma of the kidney there were 3 squamous cell or epidermoid carcinomas. One of the patients gave a history of passing calculi. The two other histories did not suggest a previous renal infection or stones. These 3 cases are presented briefly.

The first patient, a woman, aged forty-one, was first observed in August, 1924. She had noticed a mass in her right side in October, 1923. A roentgenographic examination at that time showed a large mass in the right abdomen but no stone shadows. One week before admission to the Clinic she had had chills, fever, and pain in the right abdomen which was followed by the passing of calculi and hematuria.

Physical examination revealed a large tender, nodular mass in the right kidney region, and much pus and blood were found in the urine. The roentgenogram of the kidney, ureters, and bladder showed a greatly enlarged right kidney which was interpreted as a tumor and the cystoscopic examination revealed a cauliflower-like growth in the region of the right ureteral orifice. The ureteral orifice could not be identified and neither urine nor intravenously injected dye could be seen coming from this region. The right kidney function (estimated from the bladder urine with a catheter to left kidney pelvis) was 10 per cent, the left kidney function was 36 per cent.

Operation was undertaken, but the mass was of such huge size and was so adherent to the surrounding structures that removal was impossible. The patient died in the hospital one month later. Post-mortem examination of the right kidney showed the kidney to be five or six times the normal size. The capsule was extremely thick and adherent. There was invasion through the capsule which extended down the ureter and also involved the retroperitoneal lymph nodes, the under surface of the diaphragm, and the liver. Palpation of the bladder did not reveal any tumors and there was only slight involvement of the ureter near the bladder. There was extensive malignant invasion in the region of the duodenum and the pancreas. The pelvis of the kidney was tremendously dilated and was filled with necrotic material, but contained no stones. The central portion of the kidney showed marked degeneration and hemorrhage. Microscopic examination disclosed deeply chromatic stratified squamous epithelial cells growing in wild profusion in every direction and infiltrating deeply. Practically all the renal parenchyma had been destroyed. Pearl formations, degenerating and metaplastic cells were seen in great abundance. The diagnosis was squamous cell carcinoma of the kidney probably arising in the renal pelvis.

The second patient was a man, aged fifty-two, who was admitted to the Clinic on April 14, 1933, complaining of pain in the back, blood in the urine and nocturia, which had persisted for ten weeks. There was no history of previous genitourinary trouble or the passage of calculi.

The physical examination revealed a movable tumor in the right kidney region. Laboratory examinations showed numerous red and white blood cells in the urine and an increase of urea in the blood. A roentgenogram of the chest showed no evidence of metastasis. Considerable bladder trabeculation was apparent on cystoscopic examination and the specimen collected from the right ureter was bloody. The pyelogram showed marked compression and infiltration of the upper three-fourths of the kidney. This was interpreted as carcinoma of the kidney.

The patient was given a complete course of preoperative roentgen therapy and a right nephrectomy was performed April 28, 1933. The kidney was slightly enlarged but normal in contour. On the anterior surface of the kidney and extending out from the hilum was a bulging tumor measuring 7.5 by 6 cm. The upper half of the kidney cortex was considerably scarred. A few cortical cysts were present. The tumor had infiltrated and replaced the hilar and peripelvic fat and had sent branches up between the pyramids. It was not well circumscribed and diffusely infiltrating. There were no stones present. A large branch of the renal artery was infiltrated and occluded by the tumor.

Various sections through the kidney pelvis showed normal pelvic mucosa, complete loss of mucosa, metaplastic changes, ulcerated mucosa, and replacement of the mucosa by an infiltrating squamous cell carcinomatous growth. The tumor was diffusely infiltrating outward from the renal pelvis into the surrounding medulla, cortex and the peripelvic fat. There was marked atrophy and fibrosis of the kidney tissue and involvement of the renal vein and artery, both infiltration and thrombi. The microscopic diagnosis was squamous cell carcinoma of the right kidney originating in the pelvis.

The patient's convalescence was uneventful. One month after operation he reported for observation. He looked well, had a wonderful appetite, and had gained 6½ pounds. One month later he looked well but had begun to feel a little weak. Four months after operation a roentgenogram of the chest showed definite metastases, and the patient is now declining rapidly.

The third patient is a man, aged fifty-four, who presented himself on November 11, 1932, complaining of pain in the back and right hip, and blood in the urine. These symptoms had been present for three months. There was no history of previous kidney disease.

Physical examination revealed a small mass in the right kidney area and definite cachexia. There was a small amount of microscopic blood in the urine and an occasional pus cell. Cystoscopic examination showed no function from the right kidney with compensatory function of the left kidney. Both the pyelogram and the urogram were unsatisfactory for diagnostic purposes.

The preoperative roentgenograms of the chest and pelvis showed no evidence of metastases.

Right nephrectomy was performed on November 11, 1932. The kidney was densely adherent everywhere but particularly at the upper pole. The renal vein contained a thrombus of tumor tissue. The kidney removed was not enlarged nor deformed. There were a few small cortical cysts and the fetal lobular markings were fairly distinct. The pelvis was moderately dilated, the mucosa was rough and had small papillary-like projections. The peripelvic tissue was infiltrated with tumor tissue. All hilar structures were invaded by the tumor tissue, and the cortex and medulla were diffusely infiltrated. The ureter was stenosed. The renal artery and vein and the kidney capsule and perinephric fat were involved by the tumor.

Microscopic examination showed a thickened, somewhat papilliferous pelvic surface covered by single and multiple layers of rather large, atypical, epithelial cells, having an epidermoid appearance, but without keratinization. Extending outward from the pelvis, there were solid masses of epithelial cells of similar type diffusely infiltrating the medulla, cortex and capsule proper of the kidney. There was extensive fibrosis of the renal tissue. There was similar infiltration of the fatty extrarenal tissue.

In less than one month after operation, metastases were demonstrated in the upper ends of the femurs. These areas did not show bone changes before operation, but undoubtedly the pain which the patient complained of on admission was caused by metastases which could not be demonstrated at that time on the roentgenogram. These distant metastases occured in less than four months after the first symptom.

The clinical course and the pathology in these 3 cases parallels the course of squamous cell carcinoma as described in the literature. This lesion is rapidly fatal and the prognosis is gloomy indeed.

SUMMARY

A general review of various aspects of the problem of roentgenologic diagnosis of renal tumors is presented, in which the relative merits of retrograde and excretory urography are discussed. Pneumopyelography, with its advantages and dangers, is reviewed.

The controversy regarding pathologic classification is cited, with some of the reasons for these difficulties.

Certain problems relating to the diagnosis of renal lesions presenting themselves in clinical practice are mentioned and illustrated by case reports from the literature and the files of the Cleveland Clinic.

REFERENCES

1. BEDRNA, J., and SIMON, J. De la valeur de la pneumopyélographie dans le diagnostic des tumeurs du bassinet. *J. d'urol.*, 1929, *27*, 392–400.
2. CHAUVIN, E., EMPÉRAIRE and ESMENARD. La pneumopyélographie. *Arch. d. mal. d. reins*, 1930, *4*, 513–530.
3. EWING, J. Neoplastic Diseases. Third edition. Saunders & Co., Philadelphia, 1928.
4. GOTTESMAN, J., PERLA, D., and ELSON, J. Pathogenesis of hypernephroma. *Arch. Surg.*, 1932, *24*, 722–751.
5. GRAHAM, A. Pathology of renal tumors. *Radiology*, 1930, *15*, 531–541.
6. HERBST, W. P. Pyeloscopy; a diagnostic procedure which promises to inaugurate a new era in the recognition and satisfactory treatment of painful abnormal motility syndromes of the upper urinary tract. *J. Urol.*, 1931, *26*, 233–239.
7. JACOBS and ROSENBERG. Cited by MacKenzie and Hawthorne, ref. 12.
8. JECK, H. S. Fatal embolism due to distention of bladder with air. *Tr. Am. Ass. Genito-Urin. Surgeons*, 1932, *25*, 289–292. Also: *J. Urol.*, 1933, *29*, 597–600.
9. JENKINS, J. A., and DRENNAN, A. M. Cavernous haemangioma of the kidney; report of a case. *J. Urol.*, 1928, *20*, 97–102.
10. KRETSCHMER, H. L. Fibroblastoma (fibroma) of kidney. Report of a case with review of the literature. *Tr. Am. Ass. Genito-Urin. Surgeons*, 1931, *24*, 63–73. Also: *Surg., Gynec. & Obst.*, 1932, *54*, 524–528.
11. LEWIS. Cited by Mathé, ref. 16.
12. MACKENZIE, D. W., and HAWTHORNE, A. B. Hemangioma of the kidney; report of 2 cases and brief résumé of the literature. *J. Urol.* 1931, *26*, 205–214.
13. MACKENZIE, D. W., and RATNER, M. Tumors of renal pelvis; review of literature and report of case. *J. Urol.*, 1932, *28*, 405–418.
14. MACKEY, W. A. Haemangioma of the kidney. *Brit. J. Surg.*, 1930, *18*, 308–320.
15. MARTIN and MERTZ. Cited by MacKenzie and Hawthorne, ref. 12.
16. MATHÉ, C. P. Fatal embolus due to inflation of the bladder with air. *Surg., Gynec. & Obst.*, 1929, *48*, 429–436.
17. MEREDITH, J. M. Benign and malignant tumors of the kidney associated with renal tuberculosis. *Am. J. Surg.*, 1933, *19*, 329–334.
18. NEUWIRT, K. Pneumopyelographie. *Ztschr. f. urol. Chir.*, 1928, *25*, 409–416.
19. PIDDIGHE, A. Cited by Mathé, ref. 16.
20. SANTINI, C. Cited by Mathé, ref. 16.
21. SCHOLL, A. J. Squamous cell tumors of the kidney associated with stone; with report of two personal cases. *Tr. Am. Ass. Genito-Urin. Surgeons*, 1932, *25*, 51–58. Also: *J. Am. M. Ass.*, 1933, *100*, 236–238.
22. SCHOLL, A. J., and FOULDS, G. S. A review of urologic surgery. *Arch. Surg.*, 1925, *10*, 774–812.
23. THOMPSON, S. A. Pneumopyelography. *J. Urol.*, 1922, *7*, 285–293.
24. WADE, H. Differential diagnosis of renal tumors. *Tr. Am. Ass. Genito-Urin. Surgeons*, 1932, *25*, 385–398.
25. WELLS, H. G. Carcinoma of the kidney as sequel of calculi. *Arch. Surg.*, 1922, *5*, 356–365.
26. WILSON, R. T. Renal tumors. *Texas State J. Med.*, 1933, *28*, 617–622.

CALCIFICATION IN INTESTINAL TUBERCULOSIS*

By C. H. HEACOCK, M.D.
MEMPHIS, TENNESSEE

THE rôle of calcium in tuberculosis has always been a subject of interest. Much investigation has been done and a voluminous literature has accumulated regarding calcium metabolism and therapeusis in tuberculosis. The early writers believed that a decalcification always occurred in this disease. The majority of recent reports do not confirm their belief. Kaminsky and Davidson,[13] however, were able to collect a noteworthy series of observations from the literature and to present a study of 154 tuberculous patients in whom the average serum calcium content fell below the range of normal limits. For the most part, all these observations were made on patients with moderately or well-advanced pulmonary tuberculosis. Despite the many objections to the decalcification theory, one of the chief curative principles in tuberculosis has been recalcification. Although no decalcification is present, Monoceaux[16] admits that the tuberculous patient needs more lime than a normal person to maintain a favorable balance between intake and output of calcium.

One of the difficulties encountered by the adherents of calcium therapy was proper utilization. Stimulated by the beneficial results obtained in rickets, they turned to the vitamins and heliotherapy. Spies[17,18] showed that large repeated toxic doses of irradiated ergosterol caused calcification in the necrotic and caseous portions of both acute and chronic lesions of tuberculosis in rabbits. After observing the results of treatment in 128 cases of intestinal tuberculosis, McConkey[15] noted symptomatic improvement. Response was not so prompt, however, to intravenous injection of calcium chloride, ultraviolet radiation, or antirachitic substances such as cod-liver oil and tomato juice. He believed that in some way the symptoms of intestinal tuberculosis are dependent on calcium metabolism. In the Jefferson Hospital[11] at Philadelphia patients with pulmonary tuberculosis were similarly benefited following the use of parathyroid hormone, heliotherapy, and calcium lactate. There was no evidence that the hypercalcemia influenced specifically the deposition of lime salts in the lungs. Grayzel, Shear and Kramer[12] noted no acceleration of the healing of tuberculous lesions of the bone following the addition of irradiated ergosterol to a well-balanced diet already adequate in vitamin content. It is significant that the 4 patients with calcification in the intestines, reported here, lived in Colorado, where the intensity of ultraviolet in the solar spectrum is very high.

Because of their opacity, calcareous deposits are readily recognized and studied by the roentgenologist, who is probably more cognizant of their frequency and more interested in their significance than are those engaged in any other specialty of medicine. Roentgenologists agree generally that certain deposits are physiological. Ernst[6] concluded that calcification of the costal cartilages is a biological process seen with progressive age and cannot be considered pathological unless it occurs early in life. With advancing age the same changes are also observed in cartilages elsewhere, particularly of the spine. The deposit of lime salts in the walls of the arteries of the aged, and the phleboliths seen in the bony pelvis are so familiar to roentgenologists that they are expected and not regarded as pathological.

But calcium may be observed in many disease processes. MacCallum[14] states that the chief of these is in caseating tuber-

* Read before the Section on Radiology at the Eighty-Third Annual Session of the American Medical Association, New Orleans, La., May 9–13, 1932.

culous foci, but that any dying tissue imbedded in living tissue and accessible to the circulating fluids will gradually tend to become calcified. In those rare cases of generalized interstitial calcinosis, such as is reported by Aisenberg in a child aged six, a parathyroid disturbance is most likely. So, although the presence of calcification does not necessarily mean tuberculous infection, it may be said that calcification is the rule in old tuberculous foci, whereas in other types of infection it is the exception.

The most common site for calcareous deposits in tuberculous foci is the lymph glands. Of 151 children Fraser[8] found calcification in the tracheobronchial lymph glands in 31, in the cervical glands in 2, and in the abdominal glands in 2. Of 120 children Dunham and Smythe[5] found calcification in the mesenteric lymph glands in 17 per cent. Golden and Reeves[9] regard the presence of calcium in the abdominal lymph glands as evidence that they are or have been involved in a tuberculous process. Farrell[7] found calcification either of a pulmonary focus or of the tracheobronchial glands in 801 of 1,034 patients examined roentgenographically. Of this same series, 444, or 42.93 per cent, had deposits in the lungs. This frequency in the lungs easily places them second to the lymph glands as sites of calcium deposit in tuberculous foci. The third most common location is probably in the kidneys. In rare instances, these deposits may be seen anywhere in the body. Ball, Greene, Camp and Rowntree[6] recently reported 6 cases of tuberculosis of the suprarenal glands in which calcification was demonstrated roentgenologically.

Apparently, calcification also occurs in primary lesions of intestinal tuberculosis, as well as in the abdominal lymph glands, which are secondarily affected. I have been unable to find another report of its presence in this location. We would expect reference to it in discussions on healing, but Brown and Sampson,[3] in an excellent study of their own, and in their review of Gardner's work, failed to mention any calcification. In a recent discussion of the roentgenologic signs of healing Cherry[4] did not include calcification. While at the Pueblo Clinic, between July, 1924, and July, 1925, I examined 4 patients with scattered miliary areas of calcification, apparently in the walls of the cecum. In every case the clinical and roentgenologic findings warranted the diagnosis of intestinal tuberculosis. Since then, the only patient I have seen with similar findings was examined one year ago.

CASE REPORTS

Case 1 (No. 11077). A woman, aged thirty-five, a patient of Dr. H. A. Black, was referred for examination of the gastrointestinal tract. She was suffering with abdominal pain and alternating attacks of constipation and diarrhea and had lost some weight.

On a preliminary film multiple miliary areas of calcification were present in the region of the cecum (Fig. 1). Although I had never seen similar shadows in this area and the roentgeno-

Fig. 1. Case 1. Areas of calcification in region of cecum.

grams of the chest showed no evidence of past or present tuberculosis, intestinal tuberculosis was immediately suggested and the remainder of the examination was carried out with this condition in mind. At six hours (Fig. 2) barium was distributed from the terminal ileum to the sigmoid. There was an inconstant filling defect of the cecum. The terminal ileum was moderately dilated, serrated, and pointed as it entered the valve (Fleischner's sign). A barium enema was given a week later. The cecum filled regularly, but before a roentgenogram could be made it emptied completely (Fig. 3). These findings were regarded as typical of ileocecal tuberculosis.

FIG. 2. Case I. Pseudo filling of cecum and signs of tuberculosis in terminal ileum.

CASE II (No. 10999). A woman, aged thirty-one, a patient of Dr. W. T. H. Baker, stated that her first abdominal symptoms had appeared after a pregnancy which had terminated November 19, 1924. In the latter part of the following December she had begun to experience abdominal cramps, accompanied by some fever. She had neither constipation nor diarrhea.

During a roentgen examination of her gastrointestinal tract, January 23, 1925, multiple small areas of calcification were noted in the lower right quadrant (Fig. 4). These were thought to be in tuberculous foci, but, mind-

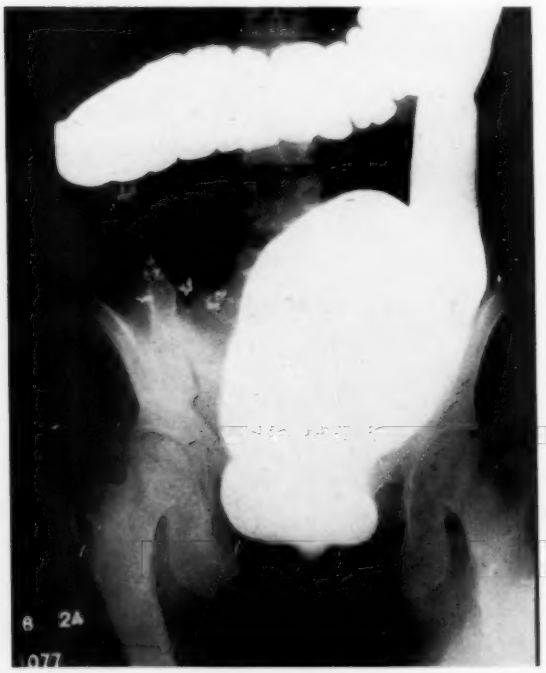


FIG. 3. Case I. Cecum intolerant to presence of barium; completely filled one minute before exposure was made.

FIG. 4. Case II. Shadows in cecal region caused by calcification. The shadow at the lower right is an artefact.

ful of the preceding case, further studies were carried out and typical roentgen signs of ileocecal tuberculosis were elicited (Fig. 5). There was also evidence of an old pulmonary tuberculosis.

The patient improved under treatment with heliotherapy, cod-liver oil, and rest in bed, but was lost sight of about three months after the roentgen examination.

Case III (No. 13327). A woman, aged thirty-seven, was referred for roentgen examination by Dr. W. T. H. Baker on January 26, 1925. She gave a history of nervousness, pain in the abdomen, chronic constipation, and occasional attacks of diarrhea lasting two or three days. She had lost 35 pounds in weight during the previous three months.

In the preliminary films mottled areas of calcification were seen in the region of the cecum (Fig. 6). They were more numerous than those observed in the two preceding cases. No lesion was found in the stomach or cap. Six hours after a barium meal portions of the terminal ileum were narrowed, segmented, and marble-like in appearance. Other portions of the terminal ileum were dilated. The cecum tolerated the presence of barium well (Fig. 7).

Fig. 6. Case III. The areas of calcification are more numerous than in the two preceding patients.

Fig. 5. Case II. During roentgenoscopic examination after barium enema the cecum was inconstantly deformed. Note narrowing and marble-like appearance of terminal ileum.

Fig. 7. Case III. The tolerance of the cecum to barium may indicate healing, but areas of dilatation, constriction, and segmentation in the ileum suggest active infection.

At twenty-four hours the small bowel and ascending colon were completely free from barium. It was felt that the active lesions were

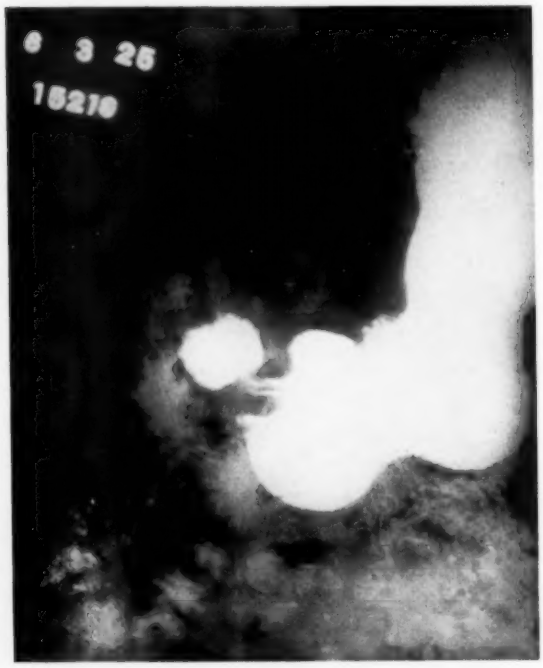


FIG. 8. Case IV. The shadows on the right differ in density and appearance from those produced by barium in the small bowel.

chiefly in the ileum and that the process in the cecum had practically healed.

Rest, ultraviolet radiation, and cod-liver oil brought about gradual improvement. In six months she was suffering very little abdominal distress and had almost regained her former weight.

CASE IV (No. 15219). A man aged fifty-one consulted Dr. W. T. H. Baker on June 2, 1925. His chief complaint was attacks of cramping pain in the abdomen, which lasted ten or fifteen minutes. He was also troubled with constipation. He stated that he had suffered with stomach "trouble" for fifteen years and that a duodenal ulcer had been reported at a previous examination elsewhere. He had lost 50 pounds in weight in the nine months preceding our observation.

No preliminary films were made. The stomach and duodenum following a barium meal were negative, but on the roentgenograms of the stomach there appeared to be areas of calcification in the ascending colon (Fig. 8). These were checked after catharsis on two occasions (Fig. 9) and the possibility of flecks of barium entirely eliminated. Examination of the ileum confirmed the diagnosis of intestinal tuberculosis. Roentgenograms of the chest showed evidence of a healed tuberculosis.

The patient improved and gained weight under treatment with ultraviolet radiation and cod-liver oil, but after three years still had occasional attacks of colicky pain.

In intestinal tuberculosis the primary infection is in the solitary lymph nodes and Peyer's patches. As they become necrotic, ulceration occurs and the lymphoid tissue does not remain to undergo caseation and finally to become the site of calcium deposits. All the writers on calcification agree that the lime salts are deposited only in dead or dying tissue, and chiefly in areas of caseation. Since, according to Goldberg, Sweany and Brown,[10] the ulcerative type makes up 80 per cent of cases of intestinal tuberculosis, the rare incidence of calcification becomes more

FIG. 9. Case IV. These shadows persisted after catharsis and were present on repeated examinations. See text.

comprehensible. At times, the infection penetrates the wall of the intestine and tubercles are formed on the peritoneal surface. The shadows on the roentgenogram are more suggestive of calcification at this site and give the appearance of miliary and conglomerate tubercles which, in some instances, have become confluent. It is unfortunate that the exact location of these calcified areas cannot be reported at this time. The present report was deferred with the hope that some areas might be studied pathologically, but none of the patients have come to operation or autopsy. The following case, however, seems instructive in determining the site of these calcareous deposits.

Case v (No. 466). A man, aged twenty-three, was admitted to St. Joseph's Hospital, Memphis, Tennessee, on May 8, 1931, on the service of Dr. T. A. Kirkland. For five years he was known to have had a tuberculous peritonitis and was now in extremis on account of acute secondary obstruction. His abdomen was distended and he was vomiting fecal matter. He lived only about thirty hours.

Roentgenograms of the abdomen revealed distended loops of small bowel with both the "herring bone" and "ladder" formations. Scattered throughout the abdomen were areas similar to those seen in the 4 patients at Pueblo (Fig. 10). The patient has received no bismuth and no history could be obtained of the ingestion of any opaque material.

I believe we are justified in ascribing the shadows in this case to lime salts deposited in tubercles on the peritoneal surface of the intestines. The similarity of the roentgen picture to those of the 4 previous cases is presumptive evidence that the sites of the deposits in the latter are on the peritoneal surface of the colon.

Calcification in tuberculosis, although not conclusive evidence that the whole process is healed, is taken as a sign of healing. In the intestines healing may occur in one area while infection is progressing in another. The mere presence of calcification in these cases was not interpreted as definite indication of healing, nor even of the presence of the disease itself. In all except the last case, which was seen only once, the routine examination of the gastrointestinal tract was carried out with special regard to the accepted technique to discover intestinal tuberculosis. In all the patients, the roentgenologic signs of the disease were present.

Fig. 10. Case v. Acute intestinal obstruction secondary to tuberculous peritonitis. The areas of calcification indicate the wide distribution.

The possibility that these shadows might be small flecks of ingested opaque material was eliminated by a second examination and the finding that the shadows were constant in size, contour, and position. Calcified abdominal glands possess a different appearance. Although they may be mottled, lime salts occur in collections which outline the contour of the gland. Injections of bismuth, mercury, and salts of other metals into the buttocks will sometimes leave an opaque residue which is not absorbed. Shadows thus produced, however, are also in clusters and are not made up of multiple miliary shadows. The clinical history will prevent their being confused with those of tuberculosis.

We cannot agree with Steinbach[19] that

the signs usually considered diagnostic of intestinal tuberculosis are highly unreliable in over 52 per cent of cases, yet we can agree that any additional signs are welcome. Although rare, calcification does occur here, as in tuberculous foci elsewhere. It is hoped that in reporting these cases interest will be aroused and a sufficient number of studies reported to permit the determination of the value of this finding in diagnosis and prognosis. The demonstration of calcium, which is possible only by the use of the roentgen ray, will probably be of highest value in an estimation of the extent of healing and of the benefit of treatment.

REFERENCES

1. AISENBERG, M. F. Ueber Calcinosis interstitialis universalis. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1929, *39*, 443–447.
2. BALL, R. G., GREENE, C. H., CAMP, J. D., and ROWNTREE, R. G. Calcification in tuberculosis of the suprarenal glands; roentgenographic study in Addison's disease. *J. Am. M. Ass.*, 1932, *98*, 954–961.
3. BROWN, L., and SAMPSON, H. L. Intestinal Tuberculosis: Diagnosis and Treatment. Chap. v and vi. Lea and Febiger, Philadelphia, 1926.
4. CHERRY, H. H. Signs of tuberculous enterocolitis. AM. J. ROENTGENOL. & RAD. THERAPY, 1932, *27*, 65–82.
5. DUNHAM, E. C., and SMYTHE, A. M. Tuberculosis of the abdominal lymph nodes. *Am. J. Dis. Child.*, 1926, *31*, 815–831.
6. ERNST, G. Die Verkalkungsvorgänge an den Rippenknorpeln. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1929, *39*, 485–494.
7. FARRELL, J. T., Jr. The incidence of roentgenographically observed calcified pulmonary foci and their significance. *Am. Rev. Tuberc.*, 1928, *18*, 344–359.
8. FRASER, F. H. The relative incidence of calcified lesions in the tracheobronchial, cervical and abdominal lymph nodes. *Am. Rev. Tuberc.*, 1928, *18*, 336–343.
9. GOLDEN, R., and REEVES, R. J. The significance of calcified abdominal lymph nodes. AM. J. ROENTGENOL. & RAD. THERAPY, 1929, *22*, 305–317.
10. GOLDBERG, B., SWEANY, H. C., and BROWN, R. W. Pathological studies on tuberculous enteritis. *Am. Rev. Tuberc.*, 1928, *18*, 744–766.
11. GORDON, B., and FLANDERS, E. Observations on persons with potential vitamin deficiency. *Am. Rev. Tuberc.*, 1931, *23*, 84–89.
12. GRAYZEL, H. G., SHEAR, M. J., and KRAMER, B. Vitamine D in bone tuberculosis in children. *Am. Rev. Tuberc.*, 1931, *24*, 106–112.
13. KAMINSKY, J., and DAVIDSON, D. L. Serum-calcium in pulmonary tuberculosis. *Am. Rev. Tuberc.*, 1931, *23*, 422–428.
14. MACCALLUM, W. G. A Textbook of Pathology. Fourth edition. W. B. Saunders and Co., Philadelphia. Chap. VIII.
15. MCCONKEY, M. The treatment of intestinal tuberculosis with cod-liver oil and tomato juice. *Am. Rev. Tuberc.*, 1930, *21*, 627–635.
16. MONOCEAUX, R. Les echanges calciques chez les tuberculeux pulmonaires. *Rev. belge de la tuberculose*, 1929, *20*, 49.
17. SPIES, T. D. The calcification of tubercles by means of irradiated ergosterol. *Am. J. Path.*, 1930, *6*, 337–346.
18. SPIES, T. D. The calcification of tubercles by means of irradiated ergosterol in experimental chronic tuberculosis. *Am. Rev. Tuberc.*, 1931, *23*, 169–174.
19. STEINBACH, M. M. Comparative radiographic and anatomical studies in intestinal tuberculosis. *Am. Rev. Tuberc.*, 1930, *21*, 77–101.

Vol. XXXII, No. 6

THE PHOTOGRAPHIC PHOTOMETRY OF ROENTGEN RAYS*

By R. B. WILSEY
ROCHESTER, NEW YORK

PHOTOGRAPHIC materials are intended primarily for the recording of images for visual inspection; they are not designed for the measurement or comparison of radiation intensities, although they may be usefully employed for this purpose if the proper technique is followed. They exhibit a number of characteristics which are of little or no importance in ordinary practical photography, but which may cause considerable difficulty when the photographic layer is used for the quantitative comparison of intensities or quantities of radiation.

The photographic method of photometry is usually an involved and laborious procedure. The films must be exposed, processed, and the necessary observations then made on the photographs. A special technique is required for photographic photometry; many precautions must be taken which are unnecessary in ordinary photographic operations. If suitable methods of direct observation are available, the work can usually be done in a fraction of the time required by photographic methods.

Occasions arise, however, when the photographic method is more suitable than any other for making the desired measurements; in some cases it is the only method practicable. Under these conditions it is important to understand clearly the limitations of the photographic method of radiation measurement, and to know what procedures should be followed in order to secure the most satisfactory results.

The properties of photographic materials which are significant from the standpoint of radiation measurement are well known to students of the scientific phases of photography. The foregoing discussion is written primarily for those who wish to use photographic methods for the measurement or comparison of radiations, but who have not had the opportunity of familiarizing themselves with the underlying principles of such methods.

The precautions to be followed in photographic methods of photometry have been described from time to time in connection with special applications of these methods; excellent examples are the discussions of the technique of photographic spectrophotometry by Howe[1] and by Harrison.[17] In the present paper, the considerations governing photographic photometry are reviewed with special reference to their applications in roentgenological problems.

In the visual photometry of ordinary light, provision is made to enable the eye to view the two illuminations in juxtaposition, and the intensity of one or both illuminations is varied until both appear identical to the eye. The eye does not serve as a measuring instrument; it merely judges the equality of the illuminations being compared. In photographic photometry, the photographic emulsion should preferably be used in the same way, to test the equality of radiations falling on adjacent areas of the film.

The various sources of error in photographic photometry, and the methods of avoiding or minimizing each one, will be discussed in turn.

PHOTOGRAPHIC SENSITIVITY VARIATIONS

Two films which have been given identical roentgen exposures must differ by about 10 per cent in speed in order to show a perceptible difference in the density of the roentgenogram, while speed differences as great as 20 or 25 per cent do not produce a serious change in roentgenographic density. In the comparison of radiation intensities, a precision of 5 per

* From the Kodak Research Laboratories and the University of Rochester, the Division of Radiology, School of Medicine and Dentistry, Rochester, N.Y.

cent or better is usually required, so that sensitivity variations which are of no importance in practical roentgenography may be quite objectionable in intensity measurements. Even the sensitivity variations over the area of a single film may exceed the permissible error of measurement of radiation intensity.

The best method of reducing the probable error due to sensitivity variation is to record the radiations being compared on closely adjacent areas of one film. The exposures should also be repeated several times on different films or portions of film and the average taken of the various observed values. If, in addition, the necessary

FIG. 1. In stationary tank development, the reaction products diffusing from the gelatin layer flow downward and restrain the development of areas over which they pass. Owing to this effect isolated areas of high density produce a light streak beneath them, while areas of low density may show a dark streak.

precautions are taken to secure uniformity of development over the areas of film involved in the measurement, the errors due to sensitivity variation can generally be reduced to less than 5 per cent, and, under favorable conditions, to as low as 2 per cent.

DEVELOPMENT

It is essential to secure the utmost uniformity of development over the various areas of the film on which measurements are to be made. This is achieved by continual and vigorous agitation of the films in the developer during the whole time of development. If the films are allowed to remain stationary, as in ordinary tank development, there is a tendency for lower areas of the film to receive a lesser degree of development than areas above them. This arises from the fact that the reaction products of development, which tend to restrain development, have a higher specific gravity than the developer, and as these products diffuse out of the emulsion layer, they flow downward over the film surface and affect the development of areas of the film over which they pass. This phenomenon is readily observable if two areas of the film, which lie side by side, differ materially in density; if the area of film below them has had a uniform exposure, the portion of it beneath the area of heavier density will show less development than the other portion in stationary tank development (Fig. 1), but will show no difference in development if the film or developer, or both, have had thorough agitation during development. This effect is not noticeable ordinarily in roentgenograms because of the fact that density or exposure variations are generally moderate and gradual in passing from one area to another. Agitation is therefore unnecessary in practical roentgenographic development; it is essential, however, when the film is used for purposes of intensity comparison or measurement.

A mechanical method of agitation of film or developer is apt to result in repetition of lines of flow of developer past the film, and may cause streaks in the developed film. The most certain method of securing a sufficiently irregular movement is to agitate the films by hand. For instance, the films may be mounted on hangers and developed in a tank large enough to permit movement of the film for some distance horizontally as well as vertically; if more than one hanger is developed at a time, they should be spaced so that developer can circulate freely between the films. The hangers should be moved back and forth in one direction,

then in another, changing the direction of movement frequently and irregularly.

The tank development, with manual agitation of the films, is the most convenient method in a roentgenological department, but tray development may be used equally well, if desired. The films should be moved back and forth, irregularly, in different directions, and the tray rocked also, to keep the developer thoroughly mixed in all parts of the tray. The depth of the developer should be sufficient to cover the films at all times.

Another method of agitation, suggested by Clark,[2] is to brush the surface of the emulsion, while immersed in the developer, with a soft brush (camel's hair). This is a very effective method of securing uniformity of development over the area of a film. The brush should be slightly wider than the film so that the whole area of the film is covered by each stroke. The brush should be moved back and forth over the emulsion continually; about forty strokes per minute gives adequate agitation of the developer over the surface of the emulsion.

Brush development may be applied very conveniently in the development of single-coated films or plates in a tray. In case the film is coated with emulsion on both sides it must be turned over frequently so that both sides can be brushed in alternation. Lifting the film from the solution to turn it over is apt to increase fog somewhat from aerial oxidation of the developer. A better procedure would be to devise an arrangement that would brush both sides of the film simultaneously without removing the film from the solution during development.

The agitation of the films or the developer, or both, serves to carry away the reaction products of development as fast as they leave the emulsion layer, and mixes them with the developer generally so as to avoid any local effects. When the reaction products have diffused throughout the solution, they do not have any noticeable effect upon development until they have accumulated in some quantity.

About two 8″×10″ films, or equivalent area, can be developed in each liter of Eastman x-ray developer before any definite change in the activity of the developer can be detected.

Agitation increases the speed of development somewhat, depending on the method and the degree of the agitation. On the average, agitated development will produce a given photographic result in about 20 per cent less time than stationary tank development.

Even with thorough agitation of the films in the developer there is some lateral diffusion of reaction products within the emulsion layer, so that, in case of a sharp boundary between an area of high density and one of low density, the border of the latter may show a narrow line of higher transparency caused by the restraining action of the reaction products diffusing from the area of high density. This phenomenon, known as the Mackie line[3] (Fig. 2), may cause trouble in the study of the fine structure of sharp-edged photographic images.

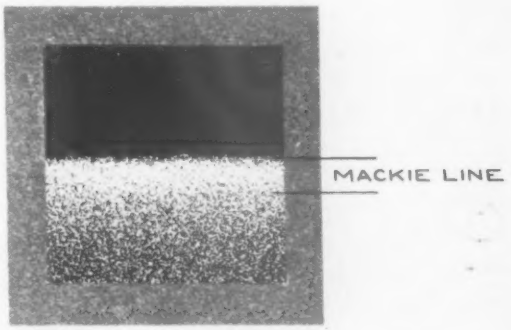


Fig. 2. Mackie line (enlarged 100 diameters). During development the reaction products which diffuse laterally in the gelatin layer from an area of high density restrain development for a slight distance into the adjacent area, and produce a light line outside the border of the high density.

In case a portion of the film receives an extremely high exposure, the scattering of light or roentgen rays into the surrounding layer of emulsion may be sufficient to produce an observable increase in blackening in the border area. In the case of roentgen exposures such irradiation effects are most

apt to arise from scattering of the rays by materials near the film, such as those of the film holder or cassette. A backing of black paper and lead foil (0.005 inch thick or more) affords the best protection of the film from scattered radiation occurring in the rear of the film. If the specimen roentgenographed has high absorption for roentgen rays, it is desirable to protect other areas of the film from direct exposure by a covering of lead. In the roentgenography of small specimens it is generally desirable to avoid any extraneous absorption or scattering effects from the usual cardboard or aluminum covers of the film container, and instead, to protect the face of the film from light by a single layer of black paper (which has been previously tested for pinholes).

It is important that such effects as the Mackie line, and halation or irradiation, be not interpreted as characteristics of the specimen photographed. In case any appearances are noted which might possibly be confused with these effects, a modification of the experimental technique, or special tests, should be devised, if possible, in an effort to differentiate clearly between the properties of the specimen and extraneous effects originating in the method of examination.

If recommendations to be made in a later section can be carried out, the exact degree of development of the films is of little or no importance; the development should approximate the conditions commonly used in developing roentgenograms, but under the proper circumstances moderate deviations from these conditions will not affect the results of the measurement.

Owing to the difficulties in accurate standardization of development, it is highly desirable to restrict photographic photometry to conditions which do not require rigid control of the degree of development. The factors of temperature and time of development can easily be controlled with adequate precision. If agitation of films or developer is accomplished by hand, as is generally preferable for purposes of uniformity of development, unavoidable variations in the vigor of the agitation will affect the degree of development. It is also difficult to be sure of the uniformity of the activity of the developer, which may be affected by variations in the quality of the chemicals, the procedure of mixing, age of the solution, etc. Because of these facts, it is almost impossible to specify and realize standard conditions of development with sufficient precision for photometric purposes. As a rule, the best that can be hoped for is to secure approximate equality of development conditions over the areas of the film used for the photometric comparison. This object is achieved by developing the film areas, required for each photometric comparison, together in one quantity of solution with the necessary agitation.

TIME-INTENSITY EFFECT

The photographic effect of a given quantity of radiation may depend considerably on the rate at which the radiation is applied to the photographic surface. In the case of exposures to light, it has been found that at very low intensities, a much greater quantity of light energy must usually be applied to produce a given photographic effect than at intermediate intensities; a similar loss in photographic efficiency may also occur at very high intensities. At intermediate intensities, that is, within the range commonly used in practical photography and roentgenography, photographic materials generally give their maximum and most uniform response to a given quantity of radiation.

When photographic effect is found to be independent of intensity or exposure time as long as the product of intensity $\times$ time remains the same, then it is said to follow the reciprocity law of Bunsen and Roscoe, which has been found to hold for many photochemical reactions. A deviation from this law is commonly called *reciprocity failure*, or *failure of the Bunsen-Roscoe law*.

Figure 3 shows a curve obtained by Jones and Hall,[4] in which density is plotted

against the logarithm of the intensity for a fixed quantity of light radiation incident upon a portrait film. As the intensity of illumination on the film was increased, the exposure time was decreased proportionately so that the total quantity of radiation remained fixed; yet the density obtained for a fixed development time was found to vary considerably according to the intensity or time rate at which the light fell on the film. The density is seen to fall off both at high and at low intensities; the maximum density occurs at an intermediate value of intensity, designated as "optimal intensity." This maximum in the curve is rather broad, so that for a moderate range of intensities in the neighborhood of optimal intensity, photographic effect is nearly independent of the intensity as long as the product of intensity and exposure time, or $I \times t$, remains constant.

This phenomenon has been investigated quite extensively with exposures to light, but experimental data on the effect with roentgen-ray exposures are rather meager. Occasional experiments have been reported in which the roentgen-ray intensity has been varied over a short range, such as one to ten,[5] or one to twenty,[6] and in these cases the photographic effect has been found independent of intensity, as long as the total quantity of radiation is the same. In any case the evidence indicates that deviations from this law are generally less with exposures to roentgen rays than to light. For instance, in the long exposures usually required for roentgen-ray diffraction photographs, sometimes occupying several days, intensifying screens have practically no intensifying action on the film; practically the whole effect is due to the direct roentgen-ray exposure. It is not known whether this effect is due to the relative insensitivity of the film toward the faint light from the screen, or to a weakening in the response of the screen to the roentgen rays; possibly both factors contribute to the total effect.

It is obvious that the time-intensity effect must be guarded against in photographic photometry. For instance, if it is found that exposure to one intensity of radiation for ten seconds produces the same photographic effect as exposure to another intensity for one second, it cannot be concluded that the latter intensity is ten times the first without previously having tested the photographic film for its time-intensity relation. It is not easy to make reliable measurements on the time-intensity relation; it is therefore preferable to carry out photographic photometry in such a way as to avoid any dependence upon this relation. In other words, the film should be exposed to the two radiations being compared for the same time; then, if the equal densities are produced (and certain other conditions fulfilled), the two radiations must be of equal intensity.

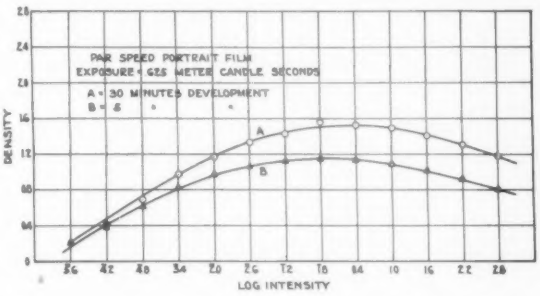


FIG. 3. Time-intensity effect on Par Speed Portrait film, exposed to white light (Jones and Hall). As intensity was increased, exposure time was decreased in the same proportion, so that total exposure, in meter-candle-seconds, was the same for each observation. In this case the photographic density varied considerably depending on the intensity at which the exposure was made.

A convenient and satisfactory method of evaluating an unknown intensity photographically is to expose an area of the film to the unknown intensity for a given exposure time; then, on successive areas along the boundary of this space, impress a series of known intensities exposed for this same time; after the film is suitably developed, the known intensity which produces the same density as the unknown indicates the value of the unknown intensity. If the density due to the unknown intensity does not accurately match any

density of the adjacent series, a curve may be plotted of the latter densities against the corresponding intensity values, and with this as a calibration curve, the intensity of the radiation being measured may be read from the corresponding density value.

The determination of the time-intensity relation with roentgen rays requires some method of changing the intensity of the radiation in a known manner without affecting its quality. The most reliable method of accomplishing this with pulsating potential generators is by variation of target film distance, utilizing the inverse square law. Even by this method, air absorption must be taken into account if refined measurements are required. An air path longer than 1 meter will absorb roentgen rays sufficiently to affect the accuracy of photographic measurements of roentgen-ray intensity. Air absorption correction can be computed with sufficient accuracy from a knowledge of the effective wave length of the roentgen-ray beam and of the spectral absorption data available on air or its constituents.

Furthermore, in making use of the inverse square law, stem radiation from the tube should be avoided by suitable diaphragming. Roentgen tubes of the self-protective type are usually constructed with a small window near the focal spot, so that it is a simple matter to diaphragm off all rays except those from the focal spot and adjacent area. While the inverse square law theoretically applies to a point source of radiation, no appreciable error arises from the finite size of the source provided the distances used are at least ten times the diameter of the source.

In the case of line focus tubes, the angular distribution of radiation from the focal spot is not quite uniform, particularly near the cathode edge of the field,[7] so that in tests involving a dependence upon the inverse square law, the radiation used should be that emitted at an angle in the neighborhood of 10 degrees or more on the cathode side of the central ray. With such a tube, it would be desirable to carry out a preliminary experiment to determine the directions in which the angular distribution of roentgen-ray intensity is sensibly uniform, and to assume the validity of the inverse square law only for radiation emitted within these directions.

This lack of uniformity of angular distribution of radiation from a line focus tube is not sufficient to be appreciable roentgenographically except for the rays which leave the target at very small angles. The target-film distance in roentgenography should be sufficient to avoid any noticeable decrease in intensity of radiation at the anode edge of the film.

In utilizing the inverse square law for variation of intensity, it is assumed that the kilovoltage and milliampere settings of the roentgen-ray machine are kept constant, and that the resulting roentgen-ray output remains constant in intensity and quality. This assumption is probably correct with roentgenographic machines under normal conditions of operation. Deep therapy machines of the pulsating potential type have been found to show a rise in voltage effect occurring with the gradual rise in temperature of the roentgen tube[8,9]; any such inconstancy of operating conditions would interfere seriously with the use of the machine for photometric purposes.

It is not advisable, with a pulsating potential machine, to attempt to vary roentgen-ray intensity in a known manner by variation of tube current, with tube voltage held constant; under such conditions, the voltage wave form is apt to change, with the possibility of a resulting change in the quality of the roentgen rays.

It is much simpler to impress a series of exposures on the film by a variation in the time of exposure, with constant roentgen-ray intensity, than by a variation in intensity with constant exposure time. An instrument, called a sensitometer, may be constructed which automatically varies the exposure time on successive areas of the film. Because of the convenience of the

time scale of exposures, it is advantageous, in some cases, to use such a scale for the photographic evaluation of intensities, after having first determined the relation between the time scale used and intensity scale over the range of intensities in which the measurements are to be made.

In general, however, the complications arising from the failure of the reciprocity law in photographic materials renders it advisable to devise experimental conditions which avoid this effect, that is, to make the exposure time the same for the two intensities being compared, and to adjust one, or both intensities until they produce equal photographic densities on the film.

INTERMITTENCY EFFECT

In visual photometry, one method of reducing the average intensity of a beam of light is to interpose in the beam a rotating disk with angular openings which permit the light to pass through for only a portion of the total time of rotation. Assume that the disk has a single angular opening of 36 degrees, thereby permitting the light to pass one-tenth of the time. If the disk is rotated rapidly enough, the eye does not notice any sensation of flicker. The light transmitted by the disk appears to be of steady intensity, and when measured photometrically, it appears to have just 10 per cent of the intensity of the original beam. In other words, the eye integrates correctly the intermittent flashes of light and properly evaluates the total light flux regardless of whether the beam of light is continuous or rapidly interrupted. In visual photometry, therefore, the use of a sector disk to reduce the average light intensity to a known extent is a valid procedure.

In photographic photometry, however, such is not always the case. The photographic effect may vary according to whether a quantity of radiation is applied continuously, at a uniform rate, to the film over a given time, or whether it is applied intermittently. Davis's[10] investigation of the intermittency effects with exposures to light shows the variations which can occur in the photographic effect, depending on whether the exposure is continuous or intermittent, and also on the character of the intermittency as specified by its frequency, and the ratio of exposure period to the non-exposure period of each cycle.

A recent investigation by Webb[11] showed a definite relation between the intermittency effect and the failure of the reciprocity law in the case of exposures to light. The experiments also showed that *if the frequency of interruption of the exposure was sufficiently high* the photographic effect was the same as for the same quantity of light applied continuously over the same total period of time; in other words, as long as the average intensity and the total exposure period were the same, it made no difference whether the exposure was continuous or intermittent.

So far as I am aware, the intermittency effect with roentgen-ray exposures has not been investigated systematically. Therefore, the extent to which this effect must be guarded against in the photometry of roentgen rays cannot be stated. The intermittency effect may be avoided entirely provided the two radiations being compared are alike in their intermittency characteristics. This would normally be the case anyway with roentgen-ray exposures, since most x-ray machines deliver roentgen rays at 120 pulses per second.

In comparing photographically a radiation emitted in 60 pulses per second with one of 120 pulses per second, or in comparing either of these with a continuous radiation, such as one produced at constant potential, the possibility of some error due to the intermittency effect exists, and before accepting the results of such measurements, tests should be made to ensure that the photographic material is not affected differentially by the variations in the intermittency characteristics of the radiations under comparison. There would seem to be little occasion, however, to use a photographic method for the comparison

of intensities of two roentgen radiations of different intermittency characteristics.

SPECTRAL SENSITIVITY OF THE PHOTOGRAPHIC EMULSION

Little is known of the variation in photographic sensitivity with the wave length of the incident roentgen rays. Spectrograms of the commonly used range of roentgen-ray wave lengths show the characteristic absorption limits of silver and bromine; the blackening shows a sudden drop, just as does the roentgen-ray absorption, in passing from the short to the long wave length side of the absorption limit, indicating that, to some extent, photographic sensitivity follows the absorption of roentgen rays by the silver bromide of the emulsion. Bouwers[12] has made some observations on the photographic response to various roentgen-ray wave lengths, and, after allowance was made for the spectral variation of absorption of the roentgen rays within the emulsion layer, the data showed an increase of photographic action with increase in wave length. In view of the complex nature of photographic sensitivity, it is to be expected that its variation with roentgen-ray wave length will also depend upon the type of emulsion.

Change of wave length of the incident radiation may affect other characteristics of the emulsion as well as sensitivity. It may change the rate at which density increases with intensity or exposure time. It may also affect the growth of density with time of development.

The experiments of Salomonson[13] and of Hodgson[14] showed the form of the density-exposure relation to depend upon the roentgen-ray quality. In the investigation of Glocker and Traub[5] this relation was found to be independent of roentgen-ray quality. Doubtless the principal reason for these variations in results was the difference in the photographic materials used in the experiments.

In view of these considerations, it is apparent that, if two radiations of different quality are compared photographically, the comparative intensities obtained may depend on the amount of exposure, or degree of development, or both, and these dependencies may vary with the type or sample of photographic material used. In view of the lack of data on the wave length sensitivity of photographic emulsions, or the photographic responses to different qualities of roentgen radiation, there is no way of knowing what to expect in any given case where radiations of different qualities are being compared. Therefore the validity of a photographic comparison of two radiation intensities may be relied upon only when the two radiations have the same quality or spectral composition.

Occasions may arise, however, when it is desirable to make a photographic comparison of the intensities of two roentgen radiations of different spectral quality. The numerical values obtained in the measurements may have no permanent significance, but they may be quite useful for purposes of comparison. In such a case, the experimental technique may be simplified, and the repeatability of results improved if the result of the measurement is independent of exposure and of degree of development. Tests should first be made to find if this is the case. If it is not, there are two alternatives; one is the search for a photographic material which meets these conditions, and the other is the accurate control and duplication of exposure and development conditions.

The problem of roentgen-ray quality determination by the photographic measurement of half-value layer belongs in this classification. The problem is the determination of the thickness of a given filter material which reduces the total roentgen-ray intensity by one-half. On a portion of the film is roentgenographed a step tablet made up of a series of thicknesses of the filter material; an adjacent portion of the film is exposed for the same time to the same quality of radiation reduced to half its original intensity, such as might be secured by an appropriate increase in target-

film distance. The half-value layer is that thickness of filter through which the same photographic density is produced as by the half intensity exposure. The two radiations being matched photographically are different in quality; therefore, the photographic response to each will depend on the spectral sensitivity of the photographic material. The half-value layer determination will vary for photographic emulsions of different spectral sensitivity, and may also vary with the exposure and degree of development. If it is necessary to use the photographic measurement of half-value layer measurement, effort should be made to select, on the basis of trial, a photographic material, which, in a given case, gives the same half-value layer for any reasonable variation in exposure and development, so that rigid precautions need not be taken to control exposure and development. The fact that the half-value layer may differ from those determined on other samples of photographic film, or from values observed by ionization measurements, is a matter which cannot be helped. The variability in the spectral sensitivity characteristics of photographic materials prevents the photographic determination of half-value layer from having any permanent or standard validity. Glasser and Rovner[18] compared photographic and ionization half-valve layers for several qualities of radiation and found that they differed by a variable factor which did not permit conversion from one to the other.

While inherent limitations prevent the photographic determination of half-value layer from being a method of precision, or of serving as a reliable standard, this does not necessarily deny its usefulness as an approximate check on radiation quality. Meyer,[19] using a single type of photographic material, found the photographic half-value layer of distinct value in the estimation of radiation quality in roentgen therapy; he states (in 1933), "for practical purposes, the photographic method would appear to suffice for orientation in the average radiologic laboratory." However, the ionization method of dosage measurement has reached a high degree of development, has been accurately standardized, and is widely used in the field of deep roentgen therapy. It appears, therefore, that the most logical development of roentgen-ray quality measurement will be along the lines of the ionization method.

The above considerations apply also to the determination of lead equivalents of protective materials. Since metallic lead and other protective materials differ more or less in constitution, they transmit different qualities of radiation, and their protective properties may be evaluated differently according to the properties of the photographic film used in the measurement. The photographic test of protective materials may serve satisfactorily as a rough approximation. The ionization method, however, has the following advantages: (1) it is more accurate; (2) it has been standardized, and (3) its indications are more nearly parallel to biological effect.

If it is desired to use photographic methods for the *precise* determination of half-value layer or the lead equivalent of roentgen-ray protective materials, the photographic film should be selected to meet the requirements specified above, and should be used in such a way as to avoid the characteristic sources of error commonly encountered in photographic photometry. In addition, *the method should be frequently checked against standardized ionization measurements* to make sure that unknown changes in spectral sensitivity of the film, or other factors, are not producing systematic changes in the results obtained.

PHOTOMETRIC SENSITIVITY

The precision of measurement in photographic photometry depends considerably on the extent to which the film can differentiate between slight differences in the intensity of the radiation incident upon it, or, in other words, upon the contrast of the film. In general, a contrasty film gives a more precise comparison of two radiation

intensities than a film of low contrast. If photographic speed is not an important factor, higher contrast may be secured by the selection of a slower film. With roentgen exposures, added contrast is also obtained if emulsion is coated on both sides of the film. For purposes of photometric sensitivity a double-coated dental roentgen-ray film should ordinarily be preferable to single-coated emulsions of similar type and also preferable to the higher speed roentgen films used in general roentgenography. The lower film densities also exhibit low contrast, so that the region of low densities should be avoided in the photographic photometry of roentgen rays. Also, very high densities should be avoided, as in this region the accuracy of density measurement or comparison is ordinarily less than in the intermediate and lower densities.*

If the problem is one of roentgen-ray absorption measurement, and the absorption of a substance under investigation is being tested in comparison with that of a standard substance, higher photometric sensitivity can usually be secured by the use of softer roentgen rays, provided a given roentgen-ray quality is not an essential feature of the experiment.

Even with all the conditions favorable, the ultimate precision obtainable in photographic photometry is limited by the unavoidable variations in sensitivity and degree of development in different areas of the film. If the best possible precision is desired, each experiment should be carried out at least three times, and the values averaged. At best it is difficult to secure values in photographic photometry dependable within less than 2 per cent.

DENSITY MEASUREMENT

In photographic photometry, the actual values of the photographic densities involved in the measurements are of no particular importance. The essential point is the determination of the equality of densities, and any device which will indicate with adequate precision whether or not two densities are equal will serve for the necessary observations to be made on the photograph.

The judgment of whether two areas of film are equal in density may be affected materially by the conditions of observation, particularly the illumination conditions surrounding the areas being compared. For the best photometric comparison, the two areas should be adjacent to each other, and other sources of light should be screened off so that the observer sees only the two areas under observation. Preferably the line of demarcation between the two areas should be such that if the areas are equal in density, one area appears to merge into the other with no apparent boundary between them.

If the two radiations being compared have been exposed on adjacent and contiguous areas of the film, the simplest way of comparing the two densities is to cut a hole in a sheet of black paper and place this hole over the two areas, masking off all other portions of the film.

Usually a suitable photometric device, such as a comparator or densitometer, achieves the best viewing conditions for photometric comparison. A chemical or biological colorimeter (such as the Duboscq type) could doubtless be readily adapted to the comparison of photographic densities. The Martens polarization photometer (to be described) is a very suitable instrument for either the comparison or measurement of photographic densities.

Since there are other problems in which the actual numerical values of photographic density are of importance, it seems desirable to discuss briefly the methods of photographic density measurement. This problem is the subject of a voluminous literature; it will be possible to point out only the principal features in this review.

A densitometer is primarily a special form of photometer for measuring the ratio of the intensity of the light transmitted to that of the light incident upon the area of

* This is not always true, as very high densities may be measured accurately with a suitable design of densitometer employing ample illumination.[15]

film or other specimen under examination. This ratio is called the transmission, T. If, for instance, the density being measured transmits $1/5$ of the light incident upon it, the transmission is $1/5$ or 0.20. Opacity, O, is defined as the reciprocal of the transmission, or $O = 1/T$, so that if the transmission is 0.20, the opacity is 5. Density is defined as the logarithm (to the base 10) of opacity, or $D = \log_{10} O = \log_{10} 1/T$. The terms density and blackening, as applied to the photographic deposit, are synonymous. The definition of density as the logarithm of the opacity is not a purely arbitrary procedure; it is in accord with one of the basic properties of the eye, since, in the main, the eye judges differences in opacity in proportion to the logarithm of the opacity, and not in proportion to the opacity itself.

The characteristic of photographic deposits which most complicates the measurement of density is the extent to which they scatter light. The developed photographic layer consists of a thin sheet of gelatin in which tiny sponge-like particles of metallic silver are imbedded. These particles both absorb and scatter light. A portion of the light transmitted is diffused, in lesser or greater degree, in all directions; whereas if an absorbing dye, instead of silver particles, were incorporated in the gelatin layer, practically all the transmitted light would proceed in the direction of the incident light.

Figure 4 shows diagrammatically a beam of parallel light falling on a photographic density; the distribution of intensity of the transmitted light is indicated by the arrows. To determine the density of the film under the conditions shown, it is necessary first to measure the ratio of the transmitted to the incident light. It is possible to collect and measure all the light transmitted by the photographic layer; the ratio of this light flux to the total incident flux would then be the total transmission, and from this value density can readily be calculated. However, suppose a photometric device having small sensitive area is placed at the point N (Fig. 4). Only a small portion of the transmitted light would be recorded, the observed transmission would have a lower value than in the previous form of measurement, and the density would result in a higher value.

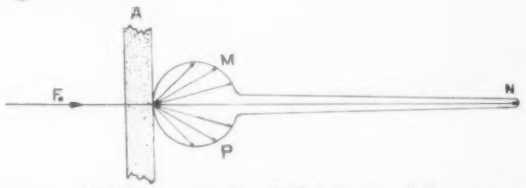


Fig. 4. When a pencil of light, F_0, falls upon a developed photographic layer, A, a portion of the light is diffused in all directions. The intensity distribution of the emergent light is indicated by the arrows.

Neither of these methods of measurement corresponds to the actual conditions of viewing a roentgenogram. A roentgen-ray illuminator is fitted with an opal glass window which diffuses the light in all directions. The roentgenogram is placed over this window, and viewed in a direction approximately perpendicular to the plane of the film. Only a tiny portion of the total light transmitted by the roentgenogram enters the observer's eye. Any photometric arrangement for reading roentgenographic densities should duplicate the essential optical conditions under which a roentgenogram is ordinarily viewed, or if these conditions are not followed, precautions should be taken to ensure that the instrument reads an equivalent density value. The densitometers commonly used in photographic laboratories actually do measure densities under the same conditions by which roentgenograms are viewed. The density to be measured is placed over a small diffusing glass window (opal glass or equivalent) of a suitable form of illuminator, and the instrument measures the intensity of the light emitted in a direction perpendicular to the plane of the film. The ratio of the intensity with the film over the window to that with the bare window (film removed) is the transmission. The opal glass window should provide an adequate degree of diffusion of the light,

otherwise too high a density value will be observed. The diffusion may be considered sufficient when the superposition of additional layers of opal glass fails to reduce the density values observed.

Probably the most commonly used form of photographic densitometer is the Martens polarization photometer (Fig. 5). The

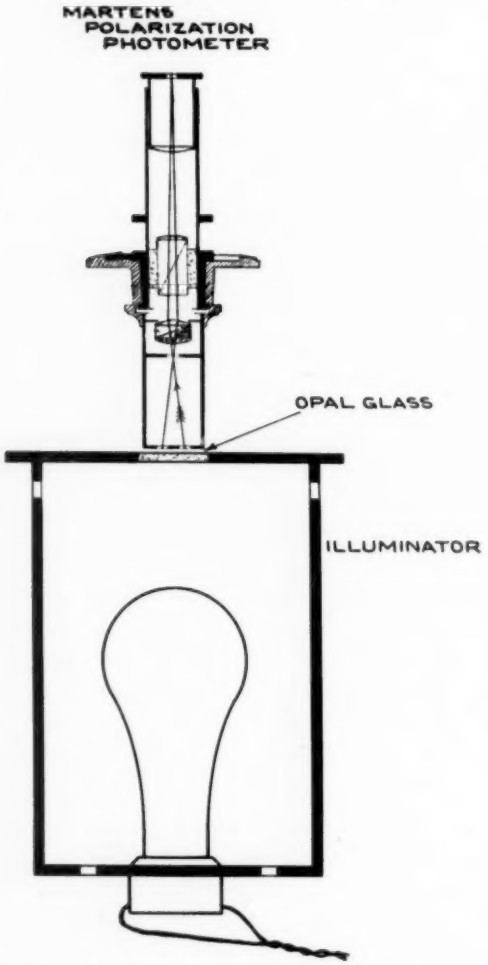


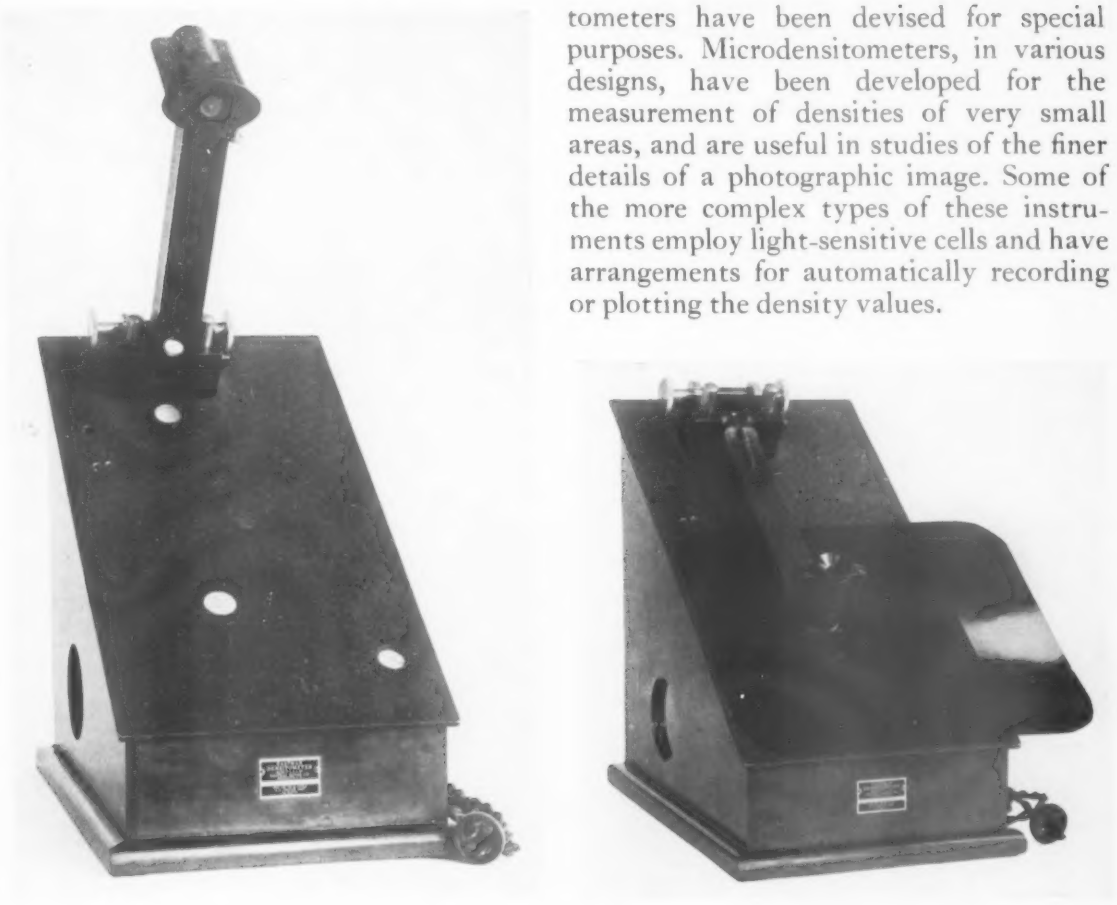
FIG. 5. Martens polarization photometer, with illuminator, for measurement of photographic densities at the edge of a film. Such an illuminator should be painted a flat white on the inside, and should be well ventilated. A special design of illuminator may be obtained for measurement of density in portions of the film away from the edge.

nose of the instrument is provided with two holes, which, ordinarily, are placed over the diffusing glass window of a lamp box or other illumination system. The illumination should be uniform so that the same quantity of light enters each of the two holes. The observer sees through the eyepiece a circular field of light divided in halves. The analyzing nicol prism is rotated until the two halves of the photometric field appear equal. The angle scale (in the first quadrant) should read 45 degrees if equal quantities of light enter each of the two holes in the nosepiece. Now, if an area of photographic film is inserted over one hole of the nosepiece, the light of one-half of the photometric field will be darkened; the analyzing nicol prism is again rotated until the two halves of the field match, and the angle scale is again read. The density value is derived by appropriate calculation from the angle reading, or may be read from a chart or table giving the relation between density and angle reading.

One handicap of this illumination system is that density can be read only a short distance from the edge of a film. By means of a system of reflecting prisms or mirrors, it is possible to illuminate the Martens densitometer in a way that will permit density measurements on areas of the film some distance away from the edge. The Martens densitometer, with this method of illumination, is available commercially.

Another form of densitometer suitable for reading densities of small areas (a fraction of a millimeter in diameter) is the Capstaff-Purdy[16] densitometer (Fig. 6). In this instrument the light intensity is varied by means of an absorbing wedge in circular form; the wedge carries a direct reading density scale. The density to be measured is placed over the central area of an opal glass window; the observer views it through a photometric eyepiece and adjusts the setting of the wedge to secure a photometric match.

In both the above types of densitometers, one electric lamp furnishes the illumination for both portions of the photometric field; it is unnecessary to maintain a constant intensity of the light emitted by



a *b*

Fig. 6, *a* and *b*. Capstaff-Purdy densitometer, for measurement of density of small areas in any portion of a film.

the lamp, since any variations affect both parts of the photometric field in equal proportion and produce no resultant effect upon the density reading.

Physical photometers, depending on some form of light-sensitive cell for their response instead of the eye, have the merit of avoiding eye strain, but, as a rule, have been more complex in their operation and more erratic in their behavior than visual photometers. However, improvements are constantly being made in the design of physical densitometers,[20] and in time they will probably displace the visual type of instrument. The stability and reliability of the Weston photronic cell led Henny[21] to its use in the design of a densitometer well suited for the measurement of densities on roentgen films.

Many forms of photographic densitometers have been devised for special purposes. Microdensitometers, in various designs, have been developed for the measurement of densities of very small areas, and are useful in studies of the finer details of a photographic image. Some of the more complex types of these instruments employ light-sensitive cells and have arrangements for automatically recording or plotting the density values.

APPLICATION OF PHOTOGRAPHIC PHOTOMETRY TO THE ROENTGEN-RAY ABSORPTION OF SECTIONS OF TEETH

The work of Warren, Bishop, Hodge, and Van Huysen[22] in their study of the roentgen-ray absorption of tooth slabs affords an excellent example of the photographic method of measurement. The procedure adopted for these measurements was based on the following considerations:

In order to fulfill the conditions necessary for satisfactory photographic photometry, the absorption of the tooth section should be compared with that of a suitable standard substance, some thick-

ness of which will transmit both the same intensity and the same quality of radiation as the portion of tooth section under examination. If a wedge of the standard substance be roentgenographed side by side with the tooth section, and the roentgenogram developed properly, the absorption of any portion of the tooth section can be expressed in terms of the thickness of standard substance giving equivalent absorption. The area of film in the shadows of tooth section and standard substance receive the identical exposure time to radiations of identical intermittency characteristics. Under these conditions, the data obtained would be independent of either the spectral sensitivity characteristics of the film, or of the quality of the roentgen rays used in the exposure. It would not be necessary to control accurately the exposure, the degree of development or the tube voltage, as the measurement would be independent of all these factors. The values obtained would have absolute and permanent significance and could readily be repeated by other observers using other photographic materials, other conditions of exposure and development, as long as they employed also the same standard absorbing substance.

It was found that aluminum fulfilled all the above conditions as a standard substance for the specification of the roentgen-ray absorption of dentine. Further details of the method are set forth in the original paper.

DISCUSSION

The sensitive nature of the photographic emulsion necessitates accurate control and elaborate precautions throughout all the manufacturing processes. It is not a simple matter to maintain sufficient uniformity of photographic sensitivity for the practical requirements of roentgenography, and while progress in manufacturing methods will continue, any improvements in photographic materials of importance in photographic photometry are apt to be rather gradual. Accidental variations in sensitivity and degree of development over the area of a film cannot be avoided and the necessary precautions must be followed to minimize their effect in photographic photometry.

Such phenomena as the time-intensity effect, the intermittency effect, and the spectral sensitivity of photographic materials with roentgen-ray exposures are poorly understood. These characteristics may vary greatly from one emulsion type to another. The changes made in any type of film, such as roentgen-ray film, to render it more suitable for the purposes for which it is intended, may affect its spectral sensitivity, its time-intensity effect, and intermittency effect sufficiently to be noticeable in the photographic method of intensity measurement. In the absence of adequate investigations of these effects it is impossible to lay down any definite laws which they will follow. Possibly these characteristics may change with the age of a film. As a rule the photographic phenomena occurring with roentgen-ray exposures seem to show less variation than with exposures to ordinary light, but this generalization cannot be depended upon as many of the effects observed with exposures to light have not been systematically investigated with roentgen-ray exposures. There appears to be no way of avoiding the necessity of carrying out photographic photometry by methods which avoid the influence of these various photographic characteristics if data of permanent and absolute significance are to be obtained; otherwise the numerical values obtained will depend on the special properties of the photographic material used.

SUMMARY

The principal factors affecting the reliability of measurements in photographic photometry are: variations in sensitivity, variations in degree of development, the time-intensity effect, the intermittency effect, the spectral sensitivity of the photographic material, and contrast.

To allow most suitably for the influence of these factors, the following rules should be followed:

(1) The photographic surface is to be used for testing the equality of the radiations being compared, as indicated by equality of the photographic densities produced.

(2) The radiations being compared should be recorded on adjacent areas of the film, and several sets of exposures should be made and the data from them averaged.

(3) The films and developer should be agitated vigorously and continuously throughout the whole time of development.

(4) Exposure time should be the same for the radiations being compared, or else the time-intensity relation of the film should be determined by a separate experiment and corrections applied according to the results found.

(5) The radiations being compared should possess the same intermittency characteristics, or else the intermittency characteristics of the film should be determined by separate experiment in order to find the corrections to be applied for the intermittency effect.

(6) The radiations being compared should be of the same spectral quality, otherwise the results will depend upon the spectral sensitivity of the photographic emulsion and may also be affected by amount of exposure and degree of development.

(7) In general the precision in photographic photometry increases with emulsion contrast.

Several applications of the photographic photometry of roentgen rays are discussed in the light of these principles.

REFERENCES

1. Howe, H. E. On a modification of the Hilger sector photometer method for measuring ultraviolet absorption. *Phys. Rev.*, 1916, *8*, 674–688.
2. Clark, W. Standard development. *Photographic J.*, 1925, *49*, 76–89.
3. Ross, F. E. The physics of the developed photographic image. Monograph No. 2. Eastman Kodak Co., 1924, p. 142.
4. Jones, L. A., and Hall, V. C. On the relation between time and intensity in photographic exposure. *Proc. 7th Internat. Cong. Photography*, July, 1928, 115–129.
5. Glocker, R., and Traub, W. The law of photographic blackening by roentgen rays. *Phys. Ztschr.*, 1921, *22*, 345–353.
6. Dershem, E. A direct comparison of photographic and ionization methods of measuring x-ray intensities. *Phys. Rev.*, 1932, *42*, 908–909.
7. Bouwers, A., and Diepenhorst, P. Roentgen-ray intensity as a function of the angle of dispersion from the anode surface. *Fortschr. a. d. Geb. d. Rontgenstrahlen*, 1928, *38*, 894–898.
8. Gross, M. J. Transient K. V. P. and r output from an air-cooled therapy tube. *Radiology*, 1933, *20*, 14–17.
9. Taylor, L. S., and Stoneburner, C. F. Operation of thick-walled x-ray tubes on rectified potentials. *Bur. Standards J. Research*, 1933, *10*, 233–247.
10. Davis, R. Experimental study of the relation between intermittent and nonintermittent sector wheel photographic exposures. *Sc. Papers Bur. Standards*, No. 528, 1926, *21*, 95–139.
11. Webb, J. H. The relationship between reciprocity law failure and the intermittency effect in photographic exposure. *J. Optic. Soc. Am.*, 1933, *23*, 157–169.
12. Bouwers, A. Measurements of the intensity of x-rays. *Acta radiol.*, 1925, *4*, 368–377.
13. Salomonson, I. K. A. W. A difference between the action of light and x-rays on the photographic plates. *Proc. Konink. Akad. Wetensch. Amsterdam*, 1915, *18*, 671–682.
14. Hodgson, M. B. The sensitometry of roentgenographic materials. Am. J. Roentgenol., 1917, *4*, 610–618.
15. Jones, L. A. An instrument (densitometer) for the measurement of high photographic densities. *J. Optic. Soc. Am.*, 1923, *7*, 231–242.
16. Capstaff, J. G., and Purdy, R. A. A compact motion picture densitometer. *Tr. Soc. Motion Picture Engineers*, 1927, *11*, 607–612.
17. (a) Harrison, G. R. Instruments and methods used for measuring spectral light intensities by photography. *J. Opt. Soc. Am.*, 1929, *19*, 267–316.

    (b) Harrison, G. R. Photographic photometry. *J. Opt. Soc. Am.*, 1934, *24*, 59–72.

18. GLASSER, O., and ROVNER, L. E. Comparison of photographic and ionization measures of radiation quality. *Radiology*, March, 1934, *22*, 309–317.

19. (a) MEYER, W. H. The measurement of roentgen-ray quality by means of the photographic determination of the half-value layer. AM. J. ROENTGENOL. & RAD. THERAPY, 1926, *16*, 26–29.
(b) MEYER, W. H. The quality determination of roentgen rays. *Radiology*, 1933, *20*, 286–296.

20. BOUTRY, G. A. Mesure de densites photographique par la methode photoelectrique. Publications Scientifiques et Techniques du Ministere d. L'Air, Paris, 1934.

21. HENNY, G. C. An instrument for measuring the density of roentgen films. AM. J. ROENTGENOL. & RAD. THERAPY, April, 1934, *31*, 550–554.

22. WARREN, S. L., BISHOP, F. W., HODGE, H. C., and VAN HUYSEN, G. A quantitative method for studying the roentgen-ray absorption of tooth slabs. AM. J. ROENTGENOL. & RAD. THERAPY, May, 1934, *31*, 663–672.

Vol. XXXII, No. 6

THE DANGERS OF ROENTGENOSCOPY AND METHODS OF PROTECTION AGAINST THEM

II. SOME CONSIDERATIONS OF THE SIZE OF THE BEAM USED IN ROENTGENOSCOPIC EXAMINATION*

By EARL I. L. CILLEY, M.D.,
Fellow in Roentgenology, The Mayo Foundation
EUGENE T. LEDDY, M.D.,
Section on Therapeutic Radiology,
and
B. R. KIRKLIN, M.D.,
Section on Roentgenology, The Mayo Clinic
ROCHESTER, MINNESOTA

IN A previous paper[1] in this Journal we considered some of the effects of protective devices on the doses received by the roentgenoscopists at The Mayo Clinic and we pointed out that, even though the recommendations of the International Safety Committee have not been followed completely, none of the roentgenoscopists we have observed has shown the slightest evidence of any injury from roentgen rays. In that paper we gave reasons for this apparent immunity. We suggested that their practice of using the smallest possible beam during the examination was one of the most important reasons why these roentgenoscopists escaped injury.

In the literature on the subject are many studies on relationships between the size of the beam and the intensity of radiation, but since the majority of these studies are of therapeutic technique, we determined to study the effect of the size of the beam from a diagnostic point of view, using throughout the technical factors we described in a previous paper (85 kv., 5 ma., 38 cm. target-skin distance, 0.5 mm. Al + 1 cm. plywood). Since it obviously is impossible to carry out careful measurements of intensity of radiation while the patient is being examined, we decided to duplicate as closely as possible every-day working conditions by using a wax phantom to represent the patient, and in this way to obtain data on the dose delivered through the "patient" to the hand of the examiner during roentgenoscopy.

With this idea in mind we proceeded with the construction of a wax block to represent the abdomen of an average patient. We examined Desjardins' anatomic charts and, by making a small series of measurements of our own in addition, we obtained the dimensions which would be more or less standard for our purpose. It was determined, in this manner, that 21 cm. is a fair average of the thickness through the epigastrium of most patients; consequently, the wax phantom was made 21 cm. thick and 26 cm. in each of the other dimensions.

Ease of handling and its indestructibility led to the use of yellow wax of high melting point for the construction of the phantom. The wax "Syncera," was purchased from the Standard Oil Company of Indiana; it was refined wax with a melting point of from 143 to 148° F. It is somewhat harder to work than white-paraffin wax but, due to its rigidity and strength, is generally much more satisfactory.

Any attempt to determine the actual dose of radiation received by the examiner by substituting such an artificial absorbing medium as a wax phantom for the patient requires detailed consideration of a number of factors. The constantly varying size of the beam, the constantly shifting

[1] Leddy, E. T., Cilley, E. I. L., and Kirklin, B. R. The dangers of roentgenoscopy and methods of protection against them. I. General review of the problem. Am. J. Roentgenol. & Rad. Therapy, September, 1934, *32*, 360–368.

* Abstract of thesis presented by Dr. Cilley to the Faculty of the Graduate School of the University of Minnesota, in partial fulfillment of the requirements for the degree of Master of Science in Radiology. Dr. Cilley is now residing in Bellingham, Washington.

position of the operator's hand in relation to the beam, the size of the beam used, and the screening effect of the barium-filled viscus, all would seem to be of as great importance as the average thickness of the patient's body. We decided, however, to investigate in this study the effect of the size of the beam on the dose received by the examiner's hand.

To gauge the effect of the size of the beam on intensity of radiation within the beam, the wax block and the "2 c.c." Victoreen ionization chamber were exposed to the factors we have mentioned. The size of the beam was interpreted in terms of the size of the brightest area on the fluorescent screen, which corresponded to the shutter opening as measured with a patient in place and the screen in its usual position during roentgenoscopy. Three holes were bored in the wax block to a depth of 15 cm. These holes were of sufficient size to admit the ionization chamber, and they were bored in a line parallel to the face of the phantom nearest the roentgen tube at distances of 8 cm., 12 cm., and 16 cm. from this face. This was done to determine whether the distance of the chamber from the roentgen tube, and the amount of wax between the chamber and the tube, corresponding to great variations in thickness of the bodies of patients, would have any appreciable effect on the difference in intensity of radiation caused by changes in the size of the beam. The phantom was placed in position of the patient, the fluorescent screen moved to 30 cm. from the back-board of the roentgenoscope and 11.5 cm. from the adjoining surface of the wax, and the shutters of the roentgenoscope arranged so that the brightest area, as measured on the screen in this position, was 10 cm. square. The carriage supporting the tube and screen could be moved in any direction parallel to the plane of the phantom without disturbing the phantom or the size of the shutter opening. The ionization chamber was placed in each of the holes in turn, and finally in air, 1 cm. from the surface of the phantom, so that the full 21 cm. of wax was interposed between it and the tube. The average of several readings of the roentgenometer in each position was calculated. The size of the beam, checked each time the position of the tube was shifted to bring the ionization chamber into the approximate center of the beam, remained unchanged, as did the factors of voltage, current, and tube-phantom distance. The shutters were then rearranged, so that the beam with the screen at the same distance as in the other measurements was 20 cm. square, and the procedure was repeated. Briefly, increasing the size of the beam from 10 to 20 cm. approximately doubles the intensity of the beam (Table 1).

TABLE I

THE EFFECT OF SIZE OF BEAM ON INTENSITY*

Thickness of wax, cm.	Discharge time, seconds (beam 10 cm. square)	Discharge time, seconds (beam 20 cm. cm. square)	Percentage increase in dose of 20 cm. beam
8	64	38	68
12	201	87	131
16	340	160	112
21	1400	788	78
		Average	97.2

* Chamber in air 1 cm. from surface of phantom.

In other words, an operator may work approximately twice as long with his hand directly in a beam 10 cm. square as with his hand in a beam 20 cm. square and receive the same exposure. The depth dose, calculated independently first with a 10 cm. beam and then with a 20 cm. beam, was found to be, at the back of 21 cm. of wax, 0.62 per cent and 1.24 per cent, respectively. This agrees fairly well, considering the differences in roentgen machines and technique, with the work of others, most of whom used a water phantom for measurements. Some investigators have stated that the thickness of the patient's body is the most important factor in determining the dose received by the examiner. We believe the screening effect

of the barium-filled stomach to be most important, with thickness of the patient's body a close second. In a subsequent paper we will discuss the barium-filled stomach.

Since the screen always backs up the hand in making a roentgenoscopic examination, a series of trials with the screen in place was made to determine the effect of the back-scattering from it. The back-scattering from the screen, as determined by the ionization chamber, was of appreciable effect, as it increased the intensity of radiation in the case of the 10 cm. beam from 0.62 per cent to 0.67 per cent and in the case of the 20 cm. beam from 1.24 to 1.44 per cent.

To compare the intensity of radiation in the direct beam with the scattered and secondary radiation just outside the direct beam, a large (500 c.c.) ionization chamber was used. A beam large enough to include the chamber with a centimeter or so to spare on each side measured 100 sq. cm. and it was therefore considered about equal to the 10 cm. square beam. The large chamber, placed in the center of this beam discharged 25 divisions on the scale in thirty-eight seconds and, just to the side of the beam, in 136.4 seconds (Table II).

The effect of the size of the beam on "secondary" and "scattered" rays from the side of the phantom was now investigated. The block was set up as before (the holes made in the side had, of course, been plugged with wax), and the large (500 c.c.) chamber was placed approximately 30 cm. from the center of the beam (18 cm. from the side of the phantom) and opposite its middle portion, that is, 10 cm. from the back-board of the vertical roentgenoscope. A series of measurements was now made using, this time, beams 20 cm., 10 cm., and 5 cm. square; only the size of the beam was altered. Twenty-five divisions were discharged in thirty seconds with the 20 cm. beam, in ninety-nine seconds with the 10 cm. beam, and in 906 seconds with the 5 cm. beam, or a percentage change of 100, 30.3, and 3.3, respectively. These measurements indicate that the size of the beam has a very great influence on the intensity of the secondary and scattered radiation emanating from the side of the phantom, which was suggested by the marked variations in brightness noted when the screen was held to the side of a patient during examination.

Table II

COMPARISON OF RESULTS WITH LARGE CHAMBER INSIDE AND OUTSIDE 100 SQ. CM. BEAM*

Beam 100 sq. cm. 21 cm. wax	Discharge time full scale, seconds	Beam 100 sq. cm. 21 cm. wax	Discharge time full scale, seconds
500 c.c. chamber in beam	38.2	500 c.c. chamber outside beam	137.0
	38.0		137.2
	37.6		136.6
	38.2		136.4
	38.0		136.8
Average	38.0	Average	136.4

* 27.77 per cent of the radiation from the 100 sq. cm. beam is received just outside the beam.

SUMMARY AND CONCLUSION

1. From the foregoing considerations it seems self-evident that the dose received by the examiner can be minimized if he keeps the beam just as small as possible during roentgenoscopic examination of the stomach, as the dose he receives is roughly proportional to the size of the beam he uses.

2. Data are presented to show that the emphasis placed by roentgenoscopists of The Mayo Clinic on the protective value of the smallest possible beam is justified.

COMPARISON OF THE ROENTGEN AND RADIUM SPECTRUM*

FROM THE STANDPOINT OF THE PRACTICAL RADIATION THERAPIST

By R. R. RATHBONE, M.D.
WASHINGTON, D. C.

SINCE the introduction of voltages above 200 kv. peak in therapy, there has been some confusion regarding the particular portion of the gamma-ray spectrum these voltages produce. We have prepared the radium and roentgen spectrum in the form of a chart, which shows at a glance the wave lengths of gamma rays in Ångströms and the overlapping roentgen-ray wave lengths in Ångströms, for various voltages commonly employed in therapy. A practical method for comparing the function of filters in relation to their absorptive powers is also demonstrated.

The radium spectrum begins at 0.29 Å on the chart. While radium actually gives off gamma rays longer than 0.29 Å, they cannot be used in pure gamma-ray therapy because it takes at least 2 mm. of brass to absorb all the beta rays; 2 mm. of copper has essentially the same absorptive powers as 2 mm. of brass, and being commonly used in roentgen therapy is taken as the starting point for the gamma-ray spectrum. Beginning then for clinical purposes with a maximum wave length of 0.29 Å, the gamma spectrum ends at 0.0055 Å, the minimum wave length for radium (B+C). To produce this minimum wave length Mayneord[1] has computed that a voltage of 2,219 kv.p. would be necessary.

If we call the intensity of gamma rays transmitted through 2 mm. of copper 100 per cent, a filter of 4 mm. of lead reduces the intensity to 81 per cent, and a filter of 10 mm. of lead reduces the intensity to 45 per cent.

The minimum wave length produced by each voltage given on the chart is computed by means of the Planck-Einstein quantum equation. As shown, the minimum wave length for 200 kv.p. is 0.06 Å and for 1,000 kv.p. it is 0.01 Å.

We have found it convenient to think of a beam of radiation in terms of its maximum and minimum wave length. At 200 kv.p. the minimum wave length is 0.06 Å while the maximum wave length is determined entirely by the filter placed in the beam. The longest wave length transmitted by a filter depends upon the absorption coefficient of that metal. Thoraeus[2] has provided a chart showing the maximum wave length transmitted by various thicknesses of aluminum, copper, tin and lead. We have placed the common filters used in therapy under the roentgen-ray radium spectrum. For clinical purposes each filter absorbs all wave lengths to the left of its position in the spectrum and transmits all wave lengths to the right. It is an easy matter to determine the particular portion of the spectrum used with any technique, by finding the filter used, and reading the Ångströms given for that filter, and then reading to the right and determining the minimum wave length given for the kv.p. employed. For example, the technique used almost universally in this country, 200 kv.p. with 0.5 mm. copper filter, has a maximum and minimum wave length of 0.46 Å and 0.06 Å respectively. By increasing the voltage to 800 kv.p. and using a filter of 2 mm. of lead the maximum wave length becomes 0.09 Å and the minimum wave length becomes 0.015 Å. At 400 constant potential the comparative output through 10 mm. of copper would be 100 per cent, or equal to the output of 200 kv.p. through 0.5 mm. copper.

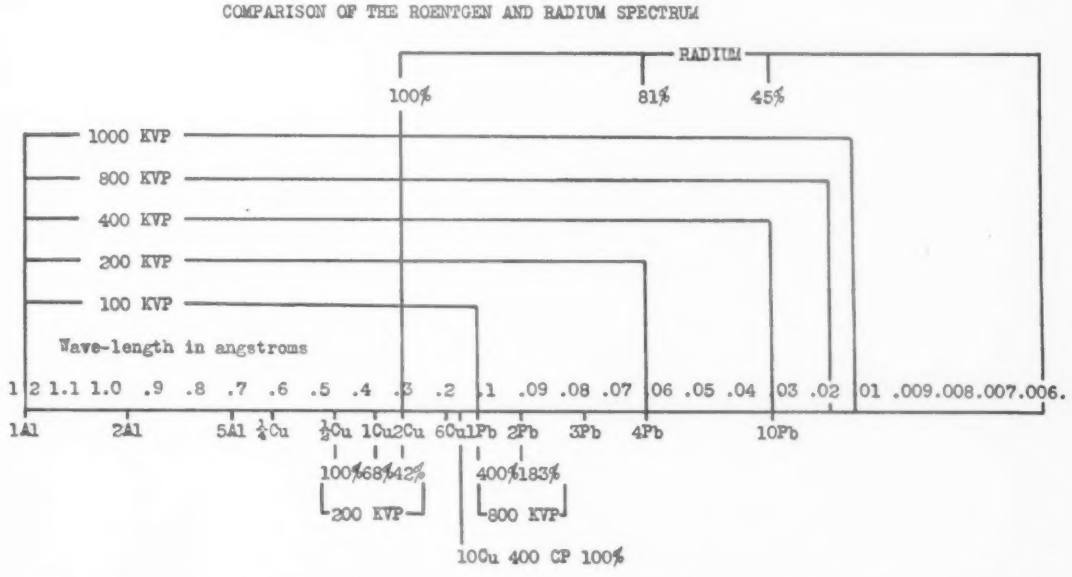
There is increasing use of 2 mm. of copper filter at 200 kv.p., using that portion

* From the Radiological Clinic of Drs. Groover, Christie and Merritt.

of the spectrum between 0.29 Å and 0.06 Å. It so happens that this corresponds to the lower 20 per cent of the radium intensity sepctrum, as the intensity of radium is reduced to 80 per cent by a filter of 4 mm. of lead, which corresponds to 0.06 Å. It does not follow that the therapeutic results of 200 kv.p. with 2 mm. of copper filter should approximate radium, as the remaining 80 per cent intensity of short wave lengths from radium produce the principal therapeutic effects.

and 0.5 mm. copper filter. If the filter is changed to 1 mm. copper, the r output drops to 68 per cent, and with 2 mm. copper the r output drops to 42 per cent. If we increase the voltage to 800 kv.p.[3] keeping the milliamperes and distance constant, the quality and intensity so improve that we can insert 1 mm. of lead in the beam and get 400 per cent, or four times the intensity produced at 200 kv.p. with 0.5 mm. copper filter. Also at 800 kv.p. 2 mm. of lead filter would give an output of 183 per cent.

Chart I


COMPARISON OF THE ROENTGEN AND RADIUM SPECTRUM
RADIUM
100%
81%
45%
1000 KVP
800 KVP
400 KVP
200 KVP
100 KVP
Wave-length in angstroms
1 .2 1.1 1.0 .9 .8 .7 .6 .5 .4 .3 .2 .1 .09 .08 .07 .06 .05 .04 .03 .02 .01 .009 .008 .007 .006.
1Al 2Al 5Al ¼Cu ½Cu 1Cu 2Cu 6Cu 1Pb 2Pb 3Pb 4Pb 10Pb
100% 68% 42%
200 KVP
400% 183%
800 KVP
100u 400 CP 100%

Note: Clinically each filter absorbs all wave lengths to the left and transmits all wave lengths to the right of its position on the spectrum.

As voltage is increased the output in radiation is increased tremendously. Admitting that the roentgen measured with high voltages and filters may not be the same we are accustomed to with 200 kv.p. therapy, we must, however, have some practical method of measurement, so we continue to measure roentgens with a condenser type r-meter. For comparative purposes we have given the approximate r output, in percentages, for several commonly used filters with constant miliamperage and distance. For example, with 10 ma. and 50 cm. distance, let us call the r output 100 per cent, produced with 200 kv.p.

Quality determinations of a beam of radiation must be made in the usual manner since the maximum and minimum wave lengths as determined from the chart give no insight as to the relative spectral intensity. The chart is submitted as a graphic aid in correlating various roentgen-ray techniques with various voltages and filters.

References

1. Mayneord, W. V. Notes on three problems of gamma-ray therapy. *Brit. J. Radiol.*, 1933, *6*, 598–614.
2. Thoraeus, Robert. *Acta radiol.*, Suppl. xv, 1932.
3. Kendrick, W. S. Personal communications.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: LAWRENCE REYNOLDS, M.D.
Assistant Editor: RUTH BIGELOW, B.S.

Editorial Board: A. C. CHRISTIE, M.D. E. H. SKINNER, M.D. LAURISTON S. TAYLOR
Advisory Board for Pathology: JAMES EWING, M.D. EUGENE L. OPIE, M.D.
Collaborating Editors: The Offices and Committee Members of the Societies of which this JOURNAL is the official organ, whose names appear on this page, are considered collaborating editors of this JOURNAL.
Foreign Collaborators: A. BÉCLÈRE, M.D., PARIS, GÖSTA FORSSELL, M.D., STOCKHOLM, G. F. HAENISCH, M.D., HAMBURG, R. LEDOUX-LEBARD, M.D., PARIS.

Publisher: CHARLES C THOMAS, 220 East Monroe St., Springfield, Illinois.

Issued Monthly. Subscription $10.00 per year, $11.00 in Canada and $12.00 in foreign countries. Advertising rates submitted on application: Editorial office, 110 Professional Building, Detroit, Mich. Office of publication 220 E. Monroe St., Springfield, Ill. Information of interest to all readers will be found on page iv.

Officers and Standing Committees

THE AMERICAN ROENTGEN RAY SOCIETY

President: George W. Grier, Pittsburgh, Pa.; *President-Elect:* Fred M. Hodges, Richmond, Va.; *1st Vice-President:* Lyell C. Kinney, San Diego, Calif.; *2d Vice-President:* John Sproull, Haverhill, Mass.; *Secretary:* E. P. Pendergrass, University Hospital, Philadelphia, Pa.; *Treasurer:* E. L. Jenkinson, 1439 S. Michigan Ave., Chicago, Ill.; *Historian:* Percy Brown, 300 Lister Bldg., Boston, Mass.

Executive Council: G. W. Grier, F. M. Hodges, L. C. Kinney, John Sproull, Lawrence Reynolds, Ross Golden, J. T. Murphy, W. A. Evans, C. B. Peirce, Sherwood Moore, E. P. Pendergrass, E. L. Jenkinson, J. B. Edwards, Charles L. Martin, Chairman, Baylor Hospital, Dallas, Texas.

Committee on Hospital Relations: J. T. Murphy, Chairman, Toledo, Ohio, L. Jaches, New York City, A. C. Christie, Washington, D. C., W. C. Hill, Cleveland, Ohio, E. H. Skinner, Kansas City, Mo.

Committee on Safety and Standards: A. U. Desjardins, Chairman, Rochester, Minn., T. Leucutia, Detroit, Mich., W. D. Coolidge, Schenectady, N.Y., G. E. Richards, Toronto, Ont., F. J. Hodges, Ann Arbor, Mich., H. K. Pancoast, Philadelphia, Pa.

Publication Committee: Ross Golden, Chairman, New York City, Ralph S. Bromer, Bryn Mawr, Pa., Merrill C. Sosman, Boston, Mass.

Finance Committee: J. Bennett Edwards, Chairman, Leonia, N.J., Leslie R. Hess, Hamilton, Ont., Raymond C. Beeler, Indianapolis, Ind.

Advisory Committee to the Moore School X-ray Laboratory: W. E. Chamberlain, Chairman, Philadelphia, R. R. Newell, San Francisco, E. P. Pendergrass, Philadelphia.

Representatives on The American Board of Radiology: B. R. Kirklin, Rochester, Minn., L. R. Sante, St. Louis, Mo., W. F. Manges, Philadelphia, Pa.

Member, National Research Council: M. C. Sosman, Boston, Mass.

Editor: Lawrence Reynolds, 110 Professional Building, Detroit, Mich.

Assistant Editor: Ruth Bigelow, 110 Professional Building, Detroit, Mich.

Editorial Board: A. C. Christie, E. H. Skinner, Lauriston S. Taylor.

Advisory Board for Pathology: James Ewing, Eugene L. Opie.

Thirty-sixth Annual Meeting: Atlantic City, N.J., Sept. 24–27, 1935.

THE AMERICAN RADIUM SOCIETY

President: William H. Cameron, New York City; *President-Elect:* G. W. Grier, Pittsburgh, Pa.; *1st Vice-President:* Maurice Lenz, New York; *2d Vice-President:* Lawrence Pomeroy, Cleveland, Ohio; *Secretary:* E. H. Skinner, 1532 Professional Bldg., Kansas City, Mo.; *Treasurer:* Zoe H. Johnston, Jenkins Arcade, Pittsburgh, Pa.

Executive Committee: Sanford Withers, Chairman, Denver, Colo., E. C. Ernst, St. Louis, Mo., R. H. Stevens, Detroit, Mich.

Program Committee: G. W. Grier, Chairman, Jenkins Arcade, Pittsburgh, Pa., Maurice Lenz, New York, Frank E. Adair, New York.

Publication Committee: E. H. Skinner, Chairman, Kansas City, Mo., Bundy Allen, Tampa, Florida, W. R. Brooksher, Ft. Smith, Ark.

Research and Standardization Committee: G. Failla, Chairman, New York, J. L. Weatherwax, Philadelphia, Pa., B. F. Schreiner, Buffalo, N. Y.

Education and Publicity Committee: G. E. Pfahler, Chairman, Philadelphia, Pa., H. H. Bowing, Rochester, Minn., Henry Schmitz, Chicago, Ill.

Representatives on The American Board of Radiology: Henry Schmitz, Chicago, R. H. Stevens, Detroit, H. K. Pancoast, Philadelphia.

Committee on Arrangements: W. S. Newcomet, Chairman, Philadelphia, G. M. Dorrance, Philadelphia, E. P. Pendergrass, Philadelphia.

20th Annual Meeting: Atlantic City, N.J., June 10–11, 1935.

EDITORIALS

POST-TRAUMATIC ACUTE BONE ATROPHY
(SUDECK'S ATROPHY)

ROENTGENOLOGISTS are quite familiar with the bone atrophy associated with immobilization of an extremity following a fracture and also with the general atrophy incident to prolonged bed confining illnesses or paralysis. These types of bone atrophy are of comparatively little importance since the affected member tends to return to its normal bone density upon the resumption of function, with a rapid disappearance of the disabling symptoms. But there is a form of atrophy, so-called post-traumatic acute bone atrophy (Sudeck's atrophy) which is not so well known, and while it is relatively rare it occurs with sufficient frequency to warrant a better knowledge of its manifestations. In this type of atrophy the roentgenogram shows a very typical patchy or moth-eaten appearance of the bones in the immediate vicinity of the traumatized area and also in the bones distal to the region which has apparently been hurt. Sudeck first called attention to this type of atrophy in 1900 and noted its importance in subsequent papers. More recently, Gurd[1] of Montreal has called attention to acute bone atrophy, emphasizing that its importance as a cause of temporary disability is not sufficiently well recognized.

The clinical appearance of a case of acute bone atrophy is fairly typical. Within a few days following an injury, which is usually trivial or relatively so, the foot or hand (as it is usually the hand or the foot which shows this particular type of atrophy), which has been somewhat swollen or painful immediately following the injury, becomes progressively more swollen and more painful, and while it is possible to palpate the pulse pressure in the blood vessels in the neighborhood of the ankle or wrist, it appears evident on examination of the limb that the capillaries are engorged and that an increase in interstitial tension has taken place. The skin becomes somewhat smooth, tends to lose its characteristic markings and may become glossy. The joint adjacent to the injury rapidly becomes stiff and either active or passive movements are extremely painful. Atrophy of ligamentous tissue accompanies the bony atrophy, as shown by the likelihood of subluxation or by the development of extensive and painful flat foot. The roentgen examination made within a few weeks following the injury shows a very characteristic patchy atrophy of the bones in the immediate neighborhood of the injury and also in the bones distal to the site of the injury. Sudeck in his original contributions divided the disease into two stages, the acute and the chronic form. It is in the acute form that the typical patchy moth-eaten appearance of the bones is seen, and it is in this stage that the roentgen differentiation is most important since the appearance of the demineralized bones may be somewhat suggestive of the presence of a tumor.

The exact pathologic changes which bring about the roentgen picture are not well understood, but there is a definite disappearance of all the transverse striae and a diminution of the longitudinal striae. The Haversian canals become very large and the cortex becomes thin. The bone absorption is not the result of osteoclastic activity. On the contrary, there seems to be a uniform loss of bone substance and

[1] Gurd, F. B. Post-traumatic acute bone atrophy (Sudeck's atrophy). *Ann. Surg.*, 1934, *99*, 449-469.

[2] Key, J. A. Local bone atrophy. Am. J. Roentgenol. & Rad. Therapy, 1933, *30*, 34-39.

not merely a depletion of the mineral salts of the bone. Associated with the bone atrophy is a very definite muscular atrophy as well as atrophy of the subcutaneous tissues and also an atrophy of the ligamentous tissue. Acute bone atrophy is most frequently seen in the short bones of the carpus and tarsus; rarely are the diaphyses of the long bones involved.

Many theories have been advanced as to the causative factor in the production of this type of atrophy. Sudeck in his original paper believed the condition was a low grade inflammation, but later, following the suggestion of Kienböck, he thought the condition to be a manifestation of trophoneurosis. Gurd, after analyzing the probable causative factors, comes to the conclusion that, "Two hypotheses, only, would appear to be worthy of any consideration, concerning the cause of the condition. One theory assumes that osteoporosis is due to disuse or absence of stimuli due to function. The second hypothesis explains the disease as being the direct result of the trauma and that the bone atrophy is consequent upon reflex action influencing the blood supply. That inactivity does result in a certain type of atrophy of bones, as of other structures, is, of course, evident. At the same time, the type of atrophy under consideration in this contribution shows both clinical and radiological features which are only rarely exhibited."

Definite experimental proof as to the causative factor in acute bone atrophy has not been established but it would appear from the experimental evidence thus far produced that it occurs as a result of nerve stimuli being transmitted through the sensory nerves from the neighborhood of the traumatized tissues through the spinal ganglia and that in consequence stasis and accumulation of blood takes place in the periphery of the affected limb. In other words, acute bone atrophy is a reflex trophoneurotic phenomenon which brings about a disturbance in the metabolism of the bones causing the bone substance to break down more rapidly than it is reconstructed. Acute bone atrophy as observed in man has not been reproduced in animals, and Gurd suggests that if the condition of acute bone atrophy as seen in man be in fact due to reflex arc stimulation in consequence of pain initiated at the site of the injury, failure to reproduce the same condition in laboratory animals may well be due to the presence of a more primitive nervous system in such animals. Whatever the causative factor which brings about these changes in acute bone atrophy may be, the condition as a clinical entity is well established in that it follows what are apparently trivial accidents at the time, it is more prevalent in the hands and feet, and is a disabling condition. The clinical picture, together with the roentgenographic appearance of the bone structure, should make the diagnosis easy and the condition occurs with sufficient frequency to warrant a knowledge of its roentgen appearance.

PASQUALE TANDOJA

GRADUATED brilliantly at Napoli in 1895 Pasquale Tandoja for several years subjected himself to serious medical preparation in the clinics and hospitals of the same city, until 1908, when attracted by the new science which was especially developed in the countries of the German tongue, he went first to Vienna and from there to Monaco to perfect himself in the roentgenology of the school of Holzknecht, Schwarz, Rieder and Grashey.

After returning to Napoli, he was appointed first assistant, then adjunct, at the surgical clinic, under the directorship of D'Antona, being in charge of the radiological department. After leaving the great clinic, which has so honored Tandoja, he continued his radiologic work at the Institutes of Rummo and Pansini until 1918.

When in 1912 a small group of pioneers proposed an Italian Radiological Society, Tandoja became one of its most enthusiastic advocates and in the first congress, held at Milano, in 1913, he distinguished himself with a masterly paper on the roentgenology of the intestine. A second time he was appointed official reporter at the sixth congress in Trieste.

In 1922 the assembly elected him President of the Society, a position which he held with enthusiasm, a great sense of responsibility and with an admirable spirit of initiative, until 1928. Even after relinquishing the presidency, Tandoja continued to enjoy in the Society great authority, because of the righteousness, straightforwardness, good will and sense of justice which he was able to instill into every one of his acts. It is not without reason that he was called "the weaver," a term that made him smile good naturedly.

At the international radiological congresses, Tandoja, endowed with great tact and courteous gentleness, and because of his knowledge of several languages, as well as his personal friendship with many eminent foreign radiologists, came to be known as the natural representative of Italian radiology, an honor which was officially confirmed by his repeated nomination as a member of the Executive Committee of the international congresses. He received other honorable nominations recently as a member of the National Research Council and the American College of Radiology. Likewise was conferred upon him the ad honorem nomination to the free professorship in radiology.

Tandoja, even after leaving the clinics to dedicate himself to his profession, continued a noteworthy scientific activity, with about twenty publications referring principally to internal medicine. He made important contributions to the roentgenology of the digestive, respiratory and urinary systems. Every new method, every new roentgenologic acquisition found in him an enthusiastic experimenter, but his eminent clinical sense and his great scientific honesty tempered the enthusiasm into a serene critical evaluation.

All this is said without rhetorical emphasis in an absolutely objective manner and with great restraint of personal affection. Nevertheless, if I may be permitted, I would like to add that he was a good and dear friend of mine, always sharing my joys and sorrows, prompted by nothing but the noblest of sentiments, happy at another's every victory and sympathizing with all his great heart in every misfortune.—FELICE PERUSSIA. *Radiol. med.*, Nov., 1934, *21*, 1338.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa. Annual Meeting: Atlantic City, N. J., Sept. 24–27, 1935.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif. Annual meeting: Atlantic City, N.J., 1935.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: Atlantic City, N.J., June 10–14, 1935.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N.Y. Annual meeting: Memphis, Tenn., Dec. 3–7, 1934.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. W. B. Firor, 1100 N. Charles St., Baltimore. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY
Secretary, E. N. Liljedahl, Los Angeles, Calif. Meets on the third Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. F. B. Bogart, Medical Arts Bldg., Chattanooga, Tenn.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. A. L. Voltz, 115 Myrtle Ave., Richmond Hill, N.Y. Meets monthly on first Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N.Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. G. Willy, 1138 N. Leavitt. Meets second Thursday of each month October to May inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. H. G. Reineke, General Hospital, Cincinnati, Ohio. Meets third Monday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. Otto Glasser, Cleveland Clinic. Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla. Meetings held twice a year, May and November.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill. Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. N. Collins, Indianapolis, Ind. Annual meeting each February 22 in Indianapolis.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. S. A. Morton, Columbia Hospital, Milwaukee, Wis. Meets monthly. Place of meeting designed by the president.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. P. S. Avery, New Brunswick, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place designated by the president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. E. F. Merrill, 30 W. 59th St., New York. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. F. C. Rulison, Medical Arts Bldg., Syracuse, N.Y. Three meetings a year—January, May, and November.

PACIFIC ROENTGEN CLUB
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. L. E. Wurster, Williamsport, Pa. Annual two-day meeting held during May, 1935; meeting to be announced.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Thomas Loughery, Germantown Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N.Y.
Secretary, Dr. W. W. Fray, Strong Memorial Hospital. Meets monthly on second Thursday from October to May, inclusive, at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN RAY SOCIETY
Secretary, Dr. P. C. Schnoebelen, Missouri Bldg., St. Louis, Mo. Meets first week of each month. Time and place of meetings designated by president.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston. Meets at time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary-Treasurer, Dr. J. H. Smith, Lubbock, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Department of Roentgenology Staff Meeting
Secretary, Dr. C. B. Peirce, University Hospital, Ann Arbor, Mich.
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Roentgen Club
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis.
Meets monthly on last Thursday, October to April, Service Memorial Institute, at 4:30 P.M.

Virginia Roentgen Ray Club
Secretary, Dr. V. W. Archer, University Hospital, University, Va.
Meets annually in October.

Cuba

Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Francisco Padron, Enrique, Villuendas 64, Havana, Cuba. Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society.
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1, or as advertised.

Electro-Therapeutic Section of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

Section on Radiology, Canadian Medical Association
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

Société de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

Société Francaise d'Electrothérapie et de Radiologie Médicale.
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, 11.52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Süd- und Westdeutsche Röntgengesellschaft
Meets annually in different cities.

Nord- und Ostdeutsche Röntgengesellschaft
Meets annually in different cities.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

Societa Italiana Radiologia Medica
Secretary, Professor M. Ponzio, University of Turin, Turin.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Nicolae Busila, 44 Elizabeta Blvd., Bucarest.
Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

Polish Society of Radiology
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

Society of Medical Radiology in Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Society of Roentgenology
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets first Tuesday each month, October to July.

Orient

Japan X-Ray Association
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto, Japan. Meets bi-monthly on third Sunday.

TREATMENT OF HYPERKERATOSIS FROM ROENTGEN RAYS

To the Editor:

Perhaps it may interest some of your readers to know that normal salt solution used as a wet dressing, has proved beneficial in one case of very stubborn inflammatory hyperkeratosis from long use of roentgen rays. For a great many years I have used ointments and lotions of many types and formulae, but only within the last year have I resorted to sea water and normal salt solution, and I believe it is worthy of a trial. In my own case, I frequently go to sleep with a pair of cotton gloves on my hands, with a little extra padding over the back of the hands and fingers, soaked with either sea water or normal saline solution. Occasionally, in between times, a little bland jelly with a lanolin base is used.

ALBERT SOILAND

DANGERS OF ROENTGENOSCOPY

To the Editor:

The paper of Drs. E. T. Leddy, E. J. L. Cilley and B. R. Kirklin* contains a number of statements which must be endorsed, such as the fact that common leather gloves do not afford sufficient protection during roentgen palpation and that leather gloves lessen the palpatory sensation, at the same time obstructing the most important part of the roentgenoscopic image.

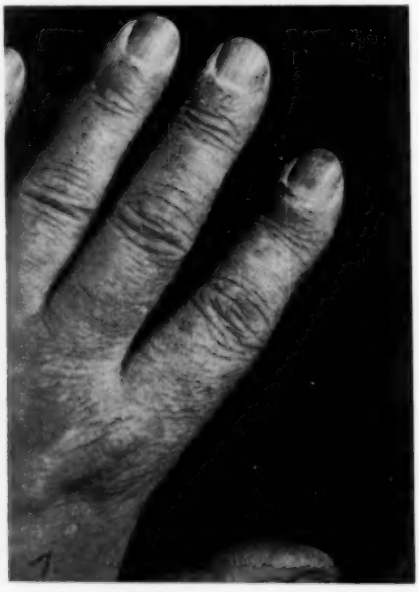


FIG. 1. The author's left hand.

FIG. 2. Holzknecht's distinctor.

As a pupil and collaborator of Holzknecht, I have since 1908 applied roentgen palpation of the stomach and intestine during roentgenoscopy in a manner exactly

FIG. 3. Screen work with Holzknecht's distinctor.

* AM. J. ROENTGENOL. & RAD. THERAPY, Sept., 1934, *32*, 360-368.

identical with that described by the authors. Until one year ago, I would have been willing to endorse also their statement that palpation during roentgenoscopy carries no danger of late injury, although the nail cuticles of my left hand, which I chiefly use for palpation, presented for a long period a parchment atrophy of the skin with no symptoms. Accidentally I lately suffered a needle prick of the nail cuticle of my left index finger. This trifling injury gradually developed into an ulcer which today, after the lapse of one year, still does not show the least tendency toward healing. Since its base appears swollen, I am unable to state whether or not it presents carcinomatous degeneration (Fig. 1). I may emphasize the fact that this hand never before was exposed to direct roentgen light. The palmar side is intact.

For this reason, I would like to recommend that roentgen palpation be carried out only with the aid of Holzknecht's distinctor, that is, in two stages. The distinctor is a wooden spoon (Figs. 2 and 3) which serves for the compression of the stomach and intestines during roentgenoscopy. The transparency of the wood permits the examiner to explore the part in which he is interested by means of the spoon which is surrounded by a thin lead strip. Having located in this manner the suspicious portion of the gastric or intestinal shadow during roentgenoscopy, the current is cut off but the spoon remains pressed against the surface of the abdomen. Then it is replaced by the palpating finger. In this way the palpation is practised not during but immediately after the completion of the roentgenoscopy while the roentgen image is still fresh in mind. Although I admit that the one stage roentgen palpation is shorter and more impressive, yet on the basis of experiences on my own hand, I would no longer endorse it but would like to call the attention of American roentgenologists to the Holzknecht distinctor.

G. Schwartz

Vienna, Austria

THE AMERICAN BOARD OF RADIOLOGY

The American Board of Radiology has decided to hold a meeting on the West Coast about the middle of May, 1935, at which time candidates will be examined for certificates. The Board has chosen to do this because of the fact that there are a number of applications on file from that section of the country, and it was felt that a meeting should be held at a place where it would be convenient for such applicants to appear before the Board. Anyone who is desirous of appearing before the Board at that time should have his application completed and on file in the Secretary's office not later than March 1, 1935.

The minimum requirements for eligibility to make application for a certificate are:

1. Membership in at least one of the national radiologic societies, the American Medical Association or the Canadian Medical Association.
2. At least three years' experience in radiology during which time not less than 75 per cent of the applicant's time has been devoted to radiology.
3. That the applicant does not hold or has not applied for a certificate from a specialty board, and that he does not list himself in the American Medical Directory or elsewhere as a specialist in some branch of medicine other than radiology.
4. That at least 75 per cent of the applicant's time is being devoted to radiology.

B. R. Kirklin, M.D.
Secretary-Treasurer, American Board
of Radiology

DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., M.S., 105 Rutledge Ave., Charleston, S. C.

A NEW METHOD FOR THE DETERMINATION OF RENAL FUNCTION*

By GEORGE LEVENE, M.D., WILLIAM M. KONIKOV, M.D., *and* HELEN MATTHEWS, M.S.

BOSTON, MASSACHUSETTS

THE apparatus herein described was first introduced in 1930 in conjunction with "A New Method for the Determination of Renal Function."† Frequent inquiries regarding this device have since led us to submit the communication for publication.

Subsequent to our presentation in 1930, there has appeared in the literature[1] a description of a method which embodies a similar principle of nephelometry applied to a study of renal elimination. Our device, however, is apparently subject to a lesser degree of error and is fundamentally adaptable to use in divers arts and sciences.

The convenience and simplicity of intravenous urography has been generally recognized. The fact that the substance is eliminated through the kidneys has led several investigators[2,3] to employ it as an agent for the determination of renal function.

The following method is a simple and accurate index of renal efficiency based upon clinical application and corroborated by laboratory experimentation. The relatively high percentage of iodine in all of the products on the market intended for intravenous pyelography renders them easily discernible by the roentgen rays. Therefore, a roentgenogram of urine which contains any one of these agents will cast a shadow on the film with an intensity which will be proportionate to and vary with the amount of that particular agent in the specimen of urine. Our method is to measure the intensity of the shadow and thus obtain the concentration of iodine-containing agent in the specimen. While our original report was based upon the application of uroselectan, the method is readily used with any of the products on the market.

The apparatus (Fig. 1) consists of two parts. The first is a metal container having an aluminum bottom, *E*, and is divided longitudinally into two equal compartments, *A* and *C*, by a thin metal diaphragm *B*. Each compartment is ¾ inch wide and 1½ inches deep. The wall of one compartment is provided with a slot, *D*, which controls the depth of the column of fluid it is to contain.

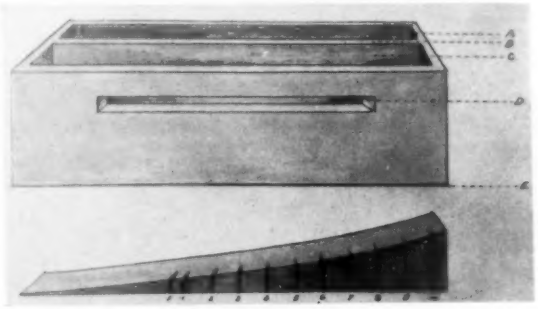


FIG. 1

The other part of the apparatus is a wedge-shaped piece of aluminum, 5 inches long and ¾ inch wide. Its superior surface is curved to conform to the values obtained in calculating the exponential absorption of roentgen rays (according to the formula $(I/I)e^{-kx}$). At definite points along one

† Presented at the joint meeting of the Staff of the Massachusetts Memorial Hospitals and the Suffolk District Medical Society, Boston, Mass., Nov. 19, 1930.

* From the Departments of Roentgenology and Urology of the Evans Memorial for Clinical Research and Preventive Medicine, Massachusetts Memorial Hospitals, Boston, Mass.

side of the wedge are vertical grooves. The intensity of the shadow of the wedge on a roentgen film, at these grooves, corresponds to the intensity of the shadow of known concentration of iodine-containing agent in the urine. The range of the scale is from 0.5 to 10 per cent.

The scale member is derived by measuring, with an ionization spectrometer, the absorption coefficients of the various percentage concentrations of the iodine-containing compound (neo-skiodan, neo-iopax etc.), and of finding the thickness of aluminum having the same absorption coefficient corresponding with the different percent ages.

The apparatus is thus readily adaptable for use in determining the density, concentration or contamination of numerous substances, by using a scale member for each specific purpose.

METHOD

Before administering the intravenous agent, the bladder is emptied. One-half hour after the injection, the bladder is again emptied and the total volume of urine voided is measured. Compartment *C* of the container is then filled with a sample of urine, up to the overflow slot, *D*. The scale rests in compartment *A*. The apparatus is placed on a roentgen film and a roentgenogram made.

It is then only necessary to compare the intensity of the shadow of the urine (containing excreted iodine compound) with a corresponding point on the scale (Fig. 2). The percentage thus obtained, multiplied by the number of cubic centimeters of urine voided, shows the number of grams of drug excreted in one-half hour.

The process is repeated at one hour and at two hours after injection. Preliminary results obtained with our apparatus tend to establish the normal range as between 50–70 per cent elimination in two hours.

The accuracy of this method compares favorably with the method recommended by Swick.[3] The latter, furthermore, requires a quantitative recovery of uroselectan from the urine—a technique too cumbersome for rapid routine determinations.

FIG. 2

The shadow produced by urine (not containing iodine compound) as determined by our scale is too small to be considered a factor of error. Since the greatest part of its intensity is due to water, and since water is common to both urine and a solution of iodine compound, the roengenographic density of the solids (urea, uric acid, creatinine, etc.) contained in the urine is a negligible factor.

It has occurred to us that a modification of this apparatus would be of value in determining liver function, after the intravenous administration of sodium tetraiodophenolphthalein. This work is now in progress.

SUMMARY AND CONCLUSIONS

A method for determining renal function, by means of a new and simple apparatus which compares roentgenographically the intensity of the shadow of urine containing excreted iodine compound with a scale corresponding to known concentrations of that substance, is practicable and accurate.

The accuracy of this method compares favorably with that of any other now employed. It possesses a further advantage of extreme simplicity.

A modified form of this apparatus is now being used to determine liver function.

REFERENCES

1. CARHART, E. C. An original method of estimating kidney function by means of the roentgen ray in intravenous urography. AM. J. ROENTGENOL. & RAD. THERAPY, 1932, *27*, 234–235.
2. HECKENBACH, W. Funktionsuntersuchungen bei der Ausscheidung des Uroselectans. *Klin. Wchnschr.*, 1930, *9*, 684–689.
3. SWICK, M. Intravenous urography by means of the sodium salt of 5-idio-2-pyridon-N-acetic acid. *J. Am. M. Ass.*, 1930, *95*, 1403–1409.

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

Head

CARSON, P. C., and HELLWIG, C. A.: Multiple intracranial tumors in children 821
MUSCETTOLA, G.: Some cases of odontogenous sinusitis of the antrum of Highmore 821

Neck and Chest

CASATI, A.: Effect of Valsalva's experiment on the esophagus 821
BASS, MURRAY H.: Massive collapse of the lung in new-born infants 822
BENTZEN, T. E.: A case of "acute" siderosis ... 822
LENARDUZZI, G.: Hernia of the apex of the lung discovered by roentgen examination 822
REICHLE, H. S., and YORK, C. H.: Roentgenographic study of pulmonary disease in childhood; use of the lateral and the oblique diameters of the chest 822

Skeletal System

RYPINS, E. L.: Osteitis fibrosa cystica at an unusual age 823
SINGER, H. A., and SHABET, L. W.: Metastatic infection of bone and joints as the initial clinical manifestation of gastric neoplasms 823
STEPHENS, D. J., and BREDECK, J. F.: Aleukemic myelosis with osteosclerosis 824
BRAV, E. A.: Subchondral granulation tissue in tuberculosis of the knee joint 824
GINSBERG, S.: Roentgenographic findings in acute gonococcal synovitis of the knee treated by pneumarthrosis 825
BÖHM, M.: Infantile deformities of knee and hip 825
REED, EDWARD N.: A case of arthrokatadysis of the hip joint 825
POLI, A.: Roentgenogram in tuberculous coxitis 826
STEWART, W. J.: Aseptic necrosis of the head of the femur following traumatic dislocation of the hip joint 826
BRUNO, G., and OTTONELLO, P.: Observations on the architecture of the spongy tissue of the proximal epiphyses of the femur with special reference to the so-called Ward's triangle and the femoral spur 827
MASTURZI, A.: Roentgen examination in traumatic lesions of the tarsus 827
LAPIDUS, P. W.: Os subtibiale 827
SPEED, J. S., and BLAKE, T. H.: March foot .. 827

Blood and Lymph System

LOPO DE CARVALHO and EGAS MONIZ: The visibility of the pulmonary vessels (angiopneumography) 828
CONTE, E., and COSTA, A.: Angiopneumography 829

ROENTGEN AND RADIUM THERAPY

FRIMANN-DAHL, J., and FORSBERG, R.: Roentgen treatment of xanthomatosis 829
FOSTER, J. H.: Papillomatosis laryngis 829
COHEN, L.: Treatment of intractable laryngeal papilloma in adults 830
GOSSET, and WALLON, E.: Curie therapy in cancer of the cheeks and lips 830
VON MEYSENBUG, L.: X-ray therapy of pertussis 830
DELHERM, L., and NILUS, F.: Lumbosacral and peripheral roentgen therapy applied to sciatica 831
SCHARNAGEL, I. M.: Treatment of malignant melanomas of the skin and vulva at the Radiumhemmet, Stockholm 831
NILSSON, F.: Experience with adenocarcinoma of the cervix of the uterus 831

MISCELLANEOUS

EDITORIAL: The position of the radiologist and radiotherapist in the hospital scheme 832
POITTEVIN: New roentgen kymographic method; description of the apparatus 832
DELHERM, THOYER-ROZAT, P., FISCHGOLD and CODET: Résumé of the new roentgen kymographic technique 833
DELHERM, L., BORDET, E., THOYER-ROZAT, P., and FISCHGOLD, H.: Roentgen kymographic curves of the cardiac revolution 833
BERNARD, L., PELLISSIER, and SILBERMANN: Roentgen kymography in phthisiologic practice 834
ADAMS, W. E., and LIVINGSTONE, H. M.: Lobectomy and pneumectomy in dogs 834
SEGRE, M.: A new apparatus for stereoroentgenoscopy and stereoroentgenography ... 835
SANDERA, R.: An apparatus for focussing typical and atypical distant roentgenograms .. 835
FRIMANN-DAHL, J.: A new projection for the roentgenology of the optic foramen 835
CAPUA, A.: Demonstration of the lymphatics of the pleura by means of intrapleural injections of thorotrast 835
ZACHRISSON, C. G.: A new suspension medium for barium sulphate in examination of the digestive tract 836
MILESI, G.: Study of the biological action of roentgen rays: 836
BERNSTEIN, M. A.: Experimental production of arthritis by artificially produced passive congestion 836
BANNER, E. H. W.: High-voltage generators for x-ray apparatus 837
MAYNEORD, W. V., and ROBERTS, J. E.: Measurements of high-voltage x-rays 837
FORSSBERG, A.: The time factor in the biological action of roentgen rays 837
OVERGAARD, K.: An apparatus for marking the desired direction of the roentgen ray 838

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Carson, P. C., and Hellwig, C. A. Multiple intracranial tumors in children. *Am. J. Dis. Child.*, July, 1933, *46*, 119–131.

The authors state that if the clinical diagnosis of a single cerebral tumor is often difficult, that of multiple intracranial tumors is impossible in the majority of cases. While the presence of these tumors may be suspected when there are definite indications of disease in different parts of the brain, in the reported cases the correct diagnosis was seldom made before operation or autopsy.

They report a case of suprasellar adamantinoma associated with cerebral astrocytoma with physical signs pointing to the left cerebral lesion. The suprasellar cyst was diagnosed after an exploratory aspiration. Death occurred three months later, owing to an acute meningitis, apparently of hematogenous origin. Stereoscopic roentgenograms of the skull showed evidence of pressure; the sella appeared to be within normal limits and to be bridged with bone. Because of the lack of localizing signs an injection of air was made which revealed a thinning of the left lateral ventricle in the lateral view and a pushing of the left lateral ventricle and of the third ventricle to the right in the anteroposterior view.—*R. S. Bromer.*

Muscettola, Giuseppe. Su alcuni casi di sinusiti odontogene dell'antro d'Higmoro. (Some cases of odontogenous sinusitis of the antrum of Highmore.) *Arch. di radiol.*, 1932, *8*, 372–384.

Six cases of sinusitis of the antrum of Highmore resulting from dental infection are described and illustrated with roentgenograms. The author emphasizes the importance of roentgen examination in such cases, particularly when, instead of pronounced local signs there are more or less vague and distant signs such as headache, intracranial symptoms, neuralgia of the supraorbital nerve, rhinitis, etc., apparently independent of the original tooth infection. Odontologists have a tendency to treat all such conditions conservatively and it would be in the interests of the patient to have a roentgen examination made in all cases of lesions of the teeth that resist ordinary treatment so that if the sinus is involved the necessary surgical operation may be performed.

A careful technique is of the greatest importance; the patient must be kept absolutely quiet and the proper projection used, as otherwise blurred areas may not indicate the site of the disease accurately. The roentgenograms should be made on films 18×24, or more rarely 13×18 in the occipitofrontal projection using an antidiffusor diaphragm. Sometimes it may be necessary to supplement this with roentgenograms taken in other projections. Ceresole advises a vertex-chin projection with the head very much extended so that the normal ray forms an angle of 20° with the axis from the vertex to the external auditory meatus. This avoids superposition. In special cases a contrast medium may be injected into the sinus, especially if there is a fistula.

If there is inflammation of the sinus the roentgenogram will show changes in transparency varying from a slight blurring from congestion of the mucosa to a dense massive opacity which may be uniform from exudate, or not uniform if there are fungosities. There may be changes in form and volume of the sinus, but it must be remembered that there are great variations in individuals, even normally, and this must be taken into account in interpreting the roentgenograms. Generally the size of the cavity is reduced from thickening of the walls. There may be changes in the bone walls of the cavity from reactive condensing osteitis.—*Audrey G. Morgan.*

NECK AND CHEST

Casati, Annibale. Influenza della manovra del Valsalva sull' esofago. (Effect of Valsalva's experiment on the esophagus.) *Radiol. med.*, Nov., 1933, *20*, 1403–1413.

Valsalva's experiment consists of forced expiration with the glottis closed after a deep inspiration. Roentgenograms are given which show that the esophagus is constricted during this experiment. The author believes that this constriction of the esophagus is the direct effect of the increased intrathoracic pressure and is not due to reflex nerve influences.—*Audrey G. Morgan.*

BASS, MURRAY H. Massive collapse of the lung in new-born infants. *J. Pediat.*, April, 1933, *2*, 435–443.

Three cases of massive collapse of the lung in very young infants, in which the diagnosis was made on the physical signs alone, are reported. The author states that this is a condition which can be diagnosed without roentgen-ray assistance, to be corroborated by its use later.—*W. R. Brooksher.*

BENTZEN, TORALF E. A case of "acute" siderosis. *Acta radiol.*, 1933, *14*, 344–348.

A case is described in a man aged thirty who worked for two months on a crushing machine for steel sponge. He worked for a part of the time without his mask because it was uncomfortable. The steel ore was first smelted in the usual blast furnace at 11 to 1,200° and was then powdered in a crushing machine and later made into briquettes. This powder (steel sponge) is very fine, spongy and light and can be easily carried by the wind 500 meters from the machine. While the patient was working at the plant he had a slight cough and a very small amount of sputum. He had an attack of nosebleed and went to a doctor who on roentgen examination found both lung fields infiltrated with closely packed shadows the size of a pinhead to that of a hemp seed, round or irregular in form, some sharply defined and some quite diffuse. These areas were densest around the hilus, less dense in the apices and bases of the lungs and somewhat denser on the left side than on the right. The hilus shadows were broad and dense. In the left hilus region there were two calcified shadows the size of peas and over the left diaphragm there was a slightly tent-shaped pleural adhesion. As the von Pirquet test was negative and the sedimentation of red blood cells 3 mm. per hour, no tubercle bacilli were found in the sputum and the patient had no fever and was in good general condition, the obvious diagnosis was siderosis.

The patient left the plant. A roentgen examination nine months later showed that the lung signs had practically disappeared. As this steel dust is 90 per cent iron it oxidizes readily and is eliminated from the lung tissue quite rapidly. That is the reason there were no later fibrotic changes in this case.—*Audrey G. Morgan.*

LENARDUZZI, GUERRINO. A proposito di un caso di ernia dell' apice polmonare scoperto radiologicamente. (A case of hernia of the apex of the lung discovered by roentgen examination.) *Arch. di radiol.*, 1932, *8*, 555–565.

Hernia of the lung or pneumocele means the projection of a part of the lung outside the thoracic cavity through an opening in the diaphragm or some other part of the wall of the thorax. The author believes that hernias of the apex of the lung are more frequent than is commonly realized, for though trauma in this region severe enough to cause hernia is rare the anatomical conditions are such that hernia is readily produced.

He describes a case in a young man, aged twenty-two, who came for roentgen examination on account of a pain in his shoulder. He had no symptoms at the apex whatever. But screen examination showed that when the patient coughed the clearness of the right apex rose higher than normal; the upper border of the apex rose above the 1st rib to the level of the 7th cervical vertebra; it returned to its normal position during normal respiration. To fix this picture a roentgenogram of the apices was taken while the patient performed Valsalva's maneuver. This showed the abnormally high right apex bounded by an opaque line, probably the pleura. A roentgenogram taken with the ordinary technique did not show the anomaly. The transverse processes of the 7th cervical vertebra were more developed than normally as if a rudiment of a cervical rib were attached to them. The author believes therefore that the hernia in this case was congenital. The importance of roentgen examination in demonstrating such anomalies is emphasized.—*Audrey G. Morgan.*

REICHLE, H. S., and YORK, C.H. Roentgenographic study of pulmonary disease in childhood; use of the lateral and the oblique diameters of the chest. *Am. J. Dis. Child.*, April, 1933, *45*, 771–788.

The authors discuss the limitations of the anteroposterior views of the chest in the diagnosis of pulmonary disease in childhood. A roentgenogram of the chest n any diameter presents an unreal picture of the thoracic contents, since it projects a three dimensional space on the two dimensional film and, furthermore, because of the greater density of other structures, such as the heart, diaphragm and liver, it leave; much of the lung and all of the structures of the mediastinum unrevealed. In children these structures are larger in propor-

tion to the pulmonary fields than in adults, and therefore in them this defect is more serious. The study of films taken in several diameters, anteroposterior, lateral and oblique, permits one to demonstrate the pulmonary fields hidden by such structures, and the correlated study of these views advances one considerably toward an ideal reconstruction of the thoracic contents.

They do not wish to disparage the use of roentgenoscopy and much information may be gained by its use. Films made under the guidance of a preliminary roentgenoscopy are more instructive for one can choose the position and attitude of the patient which will yield the greatest information.

The technique used is described in detail. Right and left lateral views are employed, in addition to the oblique. Careless examination of the former may miss shadows in the lungs lying posterior to the spinal column. They apparently expose all films with the patients lying on the roentgenographic table instead of in the erect posture when their physical condition permits. For the oblique views they use an angle of 15 to 20°. They point out the possibility of misinterpretation of the scapula shadows, of the shadows of the muscles of the arm and shoulder girdle, and of artefacts produced by overlying rib shadows either in normal patients or by the shadows of the rosary in rachitic patients, etc. The roentgenologic hilus contains more structures than the anatomic hilus inasmuch as in a roentgen negative not only the shadows of the main vessels and the bronchi are projected, i.e., the anatomic hilus, but also all parts of the lung and surrounding hilus tissues, through which that particular cross-section of the roentgen rays passes. In this fact also lies possibility of error in interpretation.

The diagnosis of hilar lymphadenopathy is expecially difficult. Lateral and oblique views are extremely helpful in this condition as well as in lesions such as exudates in the anterior and posterior mediastinum, interlobar exudates and pleurisy, and disease processes in the lower lobe of the left lung.—*R. S. Bromer.*

SKELETAL SYSTEM

Rypins, Edwin L. Osteitis fibrosa cystica at an unusual age. *J. Bone & Joint Surg.*, April, 1933, *15*, 509–512.

Rypins reports a case of osteitis fibrosa cystica in an infant, aged twenty months, reports of only 2 younger cases having been found in the literature. His patient walked with the right leg externally rotated and the knee locked, as in quadriceps weakness. The right tibia was bowed anteriorly and laterally, and was thickened. The tuberculin and Wassermann reactions were negative. The blood calcium was 11 mg. and the blood phosphorus, 5.2 mg. The right leg was placed in a cast for two months without any apparent improvement. Biopsy of the right tibia showd osteitis fibrosa cystica. Guinea pig injection of material failed to reveal tuberculosis.

Rypins briefly discusses the etiology of osteitis fibrosa cystica and its relationship to giant cell tumor. He thinks radiation therapy might prove of value due to the close relationship of the condition to giant cell tumor.

The roentgenograms which are reproduced show cystic areas in the upper and lower third of the right tibia and in the lower third of the fibula. Between these areas in the tibia, dense, almost eburnated, cortex is shown. In this respect the lesions differ from the usual cases of osteitis fibrosa cystica, both localized and generalized. He makes no mention of a spinal fluid Wassermann or of the Wassermann reactions, whether positive or negative, of the parents of the child.—*R. S. Bromer.*

Singer, Harry A., and Shabet, L. Willard. Metastatic infection of bone and joints as the initial clinical manifestation of gastric neoplasms. *J. Bone & Joint Surg.*, April, 1933, *15*, 491–493.

The authors have observed 3 instances in which suppurative lesions of bone and joints had their origin in silent or relatively silent gastric neoplasms. In one, reported by Wells, purulent arthritis of the knee was traced to an infected leiomyoma of the stomach. In a second patient, the only symptoms present during life were referable to an osteomyelitis of the spine. The primary focus, which was discovered at autopsy, was an ulcerated gastric carcinoma. The third case was that of a patient who entered the hospital for a purulent spondylitis and the infected carcinoma which constituted the source of the bone involvement had not caused sufficient discomfort to lead the patient to seek medical advice prior to the onset of the septic complication.

From a practical standpoint it is of significance to know that, in a patient of cancer age, an osteomyelitis or suppurative arthritis of

obscure origin may be due to an ulcerating growth in the digestive tract. Since the stomach is the most common site of primary carcinoma, a search for a gastric malignancy is warranted under these circumstances. It is also important to note that carcinomas which are prone to lead to metastatic infection are generally fungating and polypoid. This type of tumor tends to grow into the gastric lumen rather than along or beyond the walls, a circumstance which permits extirpation and favors permanent cure. In all of the 3 cases to which the authors refer, a knowledge on the part of the attending physicians and surgeons of the factors involved would have rendered the ultimate outlook more hopeful.—*R. S. Bromer.*

STEPHENS, D. J., and BREDECK, J. F. Aleukemic myelosis with osteosclerosis. *Ann. Int. Med.*, Feb., 1933, *6*, 1087–1096.

The essential lesion in osteosclerosis is an increase in thickness of the hard, cortical bone, with condensation and broadening of trabeculae and crowding of the marrow elements, which are often replaced with fibrous tissue. The condition, commonly found in infancy and childhood, is hereditary and without apparent relation to syphilis or vitamin deficiency. The primary changes are known to persist without symptoms well into adult life. Of the reported cases, about one-third have shown blood dyscrasias which may be classified as aleucemic myeloses; the remainder have been accompanied either by an anemia or by no changes in the circulating blood. The leucemoid blood picture has been observed with equal frequency in the two sexes and is not limited to any particular age period. The diagnosis of aleucemic myelosis is fulfilled by extramedullary proliferation of the myelogenous apparatus in the spleen and other organs, with young cells in the peripheral blood in the presence of a normal or but slightly elevated total white cell count. Splenomegaly is probably the most striking clinical manifestation of the syndrome. Two cases, the first in American literature, are reported in detail. In both cases the roentgen findings were considered most suggestive of a metastatic carcinomatosis of bone with reactive sclerosis, but detailed investigation failed to demonstrate any evidence of a primary tumor. In one case, rib biopsy revealed the true nature of the bone disturbance. There is a difference of opinion as to whether this is primarily a disease of blood or blood-forming organs or of bone. Osteosclerosis may be compared to metastatic carcinomatosis of bone as a primary factor in the pathogenesis of leucemoid disturbances. Aleucemic myelosis may not be a clinical entity but rather a secondary or symptomatic result of another disease localized in the bone marrow. Roentgen study of the skeletal system is indicated in all patients with this type of blood dyscrasia. Although the roentgen findings are to be confused with metastatic carcinomatosis, the long duration and chronicity of the disease, together with the lack of evidence of a primary tumor or metastasis to other regions, indicate that the bone change is not a metastatic one. There is no known therapy which influences the course of osteosclerosis.—*W. R. Brooksher.*

BRAV, ERNEST A. Subchondral granulation tissue in tuberculosis of the knee joint. *J. Bone & Joint Surg.*, July, 1933, *15*, 631–642.

Author's summary: Microscopic sections through the articular surfaces of 91 tuberculous knee joints were studied. The complete joint was available in each instance. In 41.7 per cent of the cases subchondral granulation tissue, arising from the margins of the joint, was seen to exist between the cartilage and the bone. Of the specimens in which subchondral granulations were present, there was definite evidence of tuberculosis beneath the margin and center of the cartilage in 29 per cent. Several others were extremely suggestive of tuberculosis but in them definite diagnosis could not be made. Subchondral granulation is probably a tissue reaction to an infectious process, rather than to foreign material in the form of degenerated cartilage. Whether or not it presents the actual cellular characteristics of tuberculosis, it must be considered potentially tuberculous. Subchondral granulation tissue in tuberculosis of the knee joint plays an active part in erosion of bone, demarcation of sequestra, and destruction of cartilage.—*R. S. Bromer.*

GINSBERG, SIDNEY. Roentgenographic findings in acute gonococcal synovitis of the knee treated by pneumarthrosis. *J. Bone & Joint Surg.*, July, 1933, *15*, 615–621.

The introduction of gas into the knee for the purpose of aiding the roentgenographic diagnosis of disorders of that joint has been utilized by a number of writers. Ginsberg reports 2 cases of acute gonococcal synovitis of the knee, treated by a short period of immobilization and daily aspiration and air inflation. The patients

recovered, with good functional results, in an average period of four weeks. Roentgenograms taken of the air-filled joints revealed characteristic adhesions in the suprapatellar pouch, which account for the slight functional impairment encountered in these cases.

From a study of the roentgenograms, the course and sequelae of the synovitis were considered to be as follows: (1) The inflamed synovia produced an effusion which filled all of the joint spaces. (2) Some of this effusion escaped absorption, irrigation, and repeated aspiration and became static in the dependent portions of the suprapatellar pouch and the joint proper during the period of immobilization. It soon became organized following invasion by fibroblasts and new blood vessels from the adjoining inflamed synovia. (3) During the period of active motion fine adhesions in the joint space proper were rubbed free, while those in the pouch, being less affected by joint motion were less molested and, therefore, allowed to become firmly organized.

The sequelae of the effusion, as revealed by the roentgenograms, thus suggest that early motion and frequent air aspiration and air inflation are valuable adjuncts in the intelligent treatment of this disease.—*R. S. Bromer.*

Böhm, Max. Infantile deformities of the knee and hip. *J. Bone & Joint Surg.*, July, 1933, *15*, 574–578.

Infantile deformities of the leg as for instance, knock-knee, bow-leg, or even flat foot may be produced by many different causes such as rickets, poliomyelitis, osteomyelitis or old fractures. Aside from these recognized causes, there still remains a large number of cases in which the etiology is unknown. Böhm attempts to put the etiology of these deformities on an anatomical basis. He describes the tibia and other bones of the lower extremities as found in the anthropoid. Thus the condyles of the tibia in the latter differ widely, the lateral one being much broader and higher than the medial one. In a young human fetus the upper tibial epiphysis has anthropoid characteristics. If the child grows and the tibia keeps its fetal type, a genu varum results. The knee of the anthropoid shows an interesting feature, the head of the tibia being curved backward. The same genu recurvatum is seen in the human fetus. If the recurvatum of the tibia and the round fetal shape of the femoral condyles persist in childhood, a hyper-extended knee must result.

Thus genu valgum is the result of the persistence of the anthropoid characteristic of a marked difference in the volume and the height of both femoral condyles, the medial being much higher than the lateral condyle. If the fetal underdevelopment of the lateral condyle persists, Böhm thinks it is clear that a genu valgum must result.

In cases of dislocation of the hip in very young children who have not walked and where no therapeutic manipulation has been done, the exact anatomical conditions as in the human fetus are found, namely, a lemon-shaped acetabulum which lacks a posterior roof. The persistence of this accounts for congenital dislocation of the hip joint.

Just as there is a predisposition to certain diseases, such as tuberculosis, so there is likewise in certain human beings an inherited disposition to certain infantile deformities, based upon an arrest of human development in certain parts of the skeleton, particularly the ankle, knee and hip joints and the epiphyses of the bones forming these joints. If this arrest of development continues during childhood, the erect position and the gait produce, increase, and stabilize deformities.—*R. S. Bromer.*

Reed, Edward N. A case of arthrokatadysis of the hip joint. *J. Bone & Joint Surg.*, July, 1933, *15*, 802–803.

Reed briefly reports a case of the condition previously recorded by Pomeranz as "intrapelvic protrusion of the acetabulum" and by Cary and Barnard as "arthrokatadysis of the hip joint." His patient was a young woman who at eighteen years of age had a severe attack of pain in her right hip joint which caused thigh flexion for two weeks, followed by progressive improvement. In 1927, roentgenograms were said to have shown a softening of the femoral head. She was then put in a hip spica cast, in abduction, for seven weeks, with no weight-bearing for six more weeks. Roentgenograms were again made in 1928, and she was advised to have complete rest and heliotherapy, but disregarding this advice she continued her training as a nurse. The condition progressively improved and at present she complains only of aching pain after a busy day on her feet or after a long automobile ride.

The roentgenogram at present shows the typical inward protrusion of the head of the

femur, giving the appearance of having shoved the acetabulum inward, ahead of it. The cup of the acetabulum is intact.—*R. S. Bromer.*

POLI, ANTONIO. L'indagine radiografica nella coxite tubercolare. (The roentgenogram in tuberculous coxitis.) *Radiol. med.*, Sept., 1933, *20*, 1122–1183.

The author reviews the pathological anatomy and roentgenology of tuberculous diseases of the bones and joints based on 769 cases examined clinically and roentgenologically at the Orthopedic Clinic of Milan. Among these cases the primary localization of the disease was in the bone in 75 per cent and in the synovia in only 25 per cent, the roof of the acetabulum being affected first in 50 per cent, the head of the femur in 30 per cent and the neck in 20 per cent. He then gives a detailed description of the various changes that can be seen—bone atrophy, focal symptoms, changes in the joint interline, changes in the soft parts and changes in the shape and position of the bones. These are classified according to the periods of the disease as follows: prodromal period, initial period, period of joint involvement, ulcerative-deforming period and period of repair.

In cases in which the primary focus is in the bone this focus can be revealed by roentgen examination before the joint is involved and before there are any clinical symptoms. This early diagnosis is of the greatest importance in treatment. It is also possible in favorable cases to make a roentgen differentiation between the different anatomical forms of the disease—the granular form with cavities from the destruction of trabeculae and the caseous form in which there is a very opaque wedge-shaped sequestrum. By means of roentgen examination it is also possible to make an early differentiation between osteitis and primary arthritis.

The form that is primary in the joint is characterized by intense diffuse atrophy of both the joint heads, distention of the capsule and broadening and darkening of the joint interline. Abscesses and fistulae can be localized by roentgen examination and the course of exudates through the soft parts can be followed up. Roentgen examination is also indispensable in demonstrating protrusion and perforation of the acetabulum and eventual central dislocation of the femur. It is also of value in association with clinical observation in following up the course of the disease and judging the results of treatment; also in making a prognosis.

The article is illustrated by 43 roentgenograms and followed by a long bibliography.—*Audrey G. Morgan.*

STEWART, WILLIAM J. Aseptic necrosis of the head of the femur following traumatic dislocation of the hip joint. *J. Bone & Joint Surg.*, April, 1933, *15*, 413–438.

Stewart reports a case of aseptic necrosis of the head of the femur following traumatic dislocation of the hip joint. The dislocation was reduced by the closed method, manipulation. His case is of interest because, despite the relative frequency of traumatic dislocation of the hip with accompanying tear of the ligamentum teres, no report was found in the literature of a similar case of aseptic necrosis and breaking down of a part of the head of the femur as a sequel. The chronic arthritis which followed, he regards as secondary to the necrosis. The picture is somewhat similar to that sometimes seen in intracapsular fracture of the neck of the femur, with necrosis of the head, in which bony union occurs but the head subsequently breaks down as a result of weight-bearing before bony transformation has taken place. When it becomes evident from the roentgenograms that aseptic necrosis in the femoral head from any cause has occurred, weight-bearing should be avoided during the period of repair.

Stewart attempted to reproduce the condition in dogs and rabbits by cutting the round ligament, and in some cases, also the vessels in the periosteum of the femoral neck. These experiments were only partially successful. A part of the bone died in some experiments and was transformed; but in no instance was collapse of the head and necrosis of its articular cartilage observed. The divided ligamentum teres showed a distinct tendency to unite in the experimental animals. It appeared that the vascular supply of the head of the femur by way of vessels within the femoral neck of these animals was usually sufficient to preserve the vitality of the head.

There was no regularity in the process of transformation of the femoral heads following operative circulatory interference. Apparently, the variability of the blood supply to the head is such that by interrupting identical portions of it in a series of experimental animals, identi-

cal and progressive stages of aseptic necrosis, followed by transformation of the femoral heads, could not be demonstrated.

After operative division, the ligamentum teres showed a distinct tendency to unite. No head of the femur in animals with open epiphyseal lines showed changes similar to Legg-Calvé-Perthes' disease.—*R. S. Bromer.*

Bruno, Giovanni, and Ottonello, Pietro. Osservazioni sull' architectura del tessuto spugnoso dell'epifisi prossimale del femore dell'uomo con particolare riguardo al cosi detto triangle di Ward ed allo sperone femorale. (Observations on the architecture of the spongy tissue of the proximal epiphysis of the femur with special reference to the so-called Ward's triangle and the femoral spur.) *Radiol. med.*, Sept., 1933, *20*, 1201–1206.

The authors made a study of the internal architecture of the spongy tissue of the proximal epiphysis of the femur, particularly of the zone of rarefied spongy tissue in the middle of the neck of the bone which is called the internal triangle of the femur, and of the plate of compact bone tissue which is called the spur of the femur (lamina femoris interna) which extends from the posterior wall of the neck into the greater trochanter and to which surgeons attribute great importance in the mechanism of fractures of the neck of the femur.

On comparing roentgenograms with bone sections of adult and old individuals they found that the triangle becomes larger with increasing age and that it appears larger in roentgenograms than it really is in bone sections. It corresponds to rarefied zones of spongy tissue.

The spur is visible even in sagittal roentgenograms in which it appears in the form of an areola of bone trabeculae independent of the wall of the diaphysis but connected with it and interposed in the spongy tissue of the greater trochanter like a bracket directly parallel to its anterior wall. It can be seen particularly well in lateral projections. As it is reduced in extent and thickness with advancing age and as the resistance of the neck of the femur to trauma is decreased at this age the authors conclude that the plaque is an important static element in the architecture of the epiphysis of the femur.—*Audrey G. Morgan.*

Masturzi, Antonio. L'indagine radiologica nelle lesioni traumatiche del tarso. (Roentgen examination in traumatic lesions of the tarsus.) *Radiol. med.*, 1933, *20*, 1231–1278.

The author reviews the anatomy of the tarsus and describes in detail the symptomatology and roentgen appearance of the various forms of fracture of the different bones of the tarsus. The mechanism of production of these fractures, their clinical and roentgen diagnosis and the best technique for demonstrating them are discussed. The article is profusely illustrated with roentgenograms.—*Audrey G. Morgan.*

Lapidus, Paul W. Os subtibiale; an inconstant bone over the tip of the medial malleolus. *J. Bone & Joint Surg.*, 1933, *15*, 766–771.

Lapidus reports 2 cases of a bilateral, extremely rare, inconstant bone, the os subtibiale, one in an adult and the other in a child. This bone lies at the tip of the internal malleolus. A review of the literature showed only a few reports of a similar condition. An accessory center of ossification is occasionally observed in this situation, appearing around six and fusing around thirteen years of age. Whether the cases of accessory center of ossification of the medial malleolus and cases of os subtibiale are two entirely independent conditions, or related in the respect that the os subtibiale is just an accessory center which failed to fuse to the medial malleolus, remains a moot question. The interpretation of os subtibiale as a sesamoid, Lapidus believes should be disregarded.—*R. S. Bromer.*

Speed, J. S., and Blake, T. H. March foot. *J. Bone & Joint Surg.*, 1933, *15*, 372–382.

The authors report 9 cases of march foot. They state that due to a misunderstanding of the etiology of the condition, march foot is the name given to a definite clinical entity, consisting of a painful swelling of the forefoot, often associated with an insidious spontaneous fracture of one of the metatarsal bones.

The usual history and clinical appearance are typical. A soldier after a long march, or a civilian who has been subjected to excessive foot strain, begins to complain of an indefinite pain in the forefoot, and some tenderness over the anterior portion of the second or third metatarsal. This is not sufficient to disable the patient and he continues with his duties only to have the disability increase, and after a few days a definite swelling is noticed involving the dorsal surface of the forefoot. The condition

improves with rest, but the resumption of the use of the foot aggravates the condition and it is usually only after several such attacks that the patient first consults a physician.

An edematous forefoot is often found on physical examination, most marked over the metatarsal region. Very few patients give a history of any direct trauma, either severe or trivial, that could account for the symptoms. There is usually a limp and if a fracture is present, the patient cannot stand with the weight on the ball of the affected foot.

Speed and Blake divide the cases into two groups. The first has the usual onset and progresses to a stage of swelling over the dorsum of the foot, and localized tenderness over the affected metatarsal. With rest and treatment, and frequently without treatment, the process apparently becomes arrested and after a week or ten days the swelling and pain subside and the foot returns to normal without the roentgenogram revealing any bone changes such as fracture, etc. In the second group, with an identical onset there is a progression through stages of periosteal proliferation, spontaneous fracture, and excessive callus formation. The duration of symptoms in this group is naturally much prolonged, the average being two to three months. At the end of this time the fracture is united, the callus gradually condenses and eventually disappears, leaving a bone which is perfectly normal clinically, and in the roentgenogram, no residual changes are found, or at the most, only a slight thickening of the cortex remains at the site of the fracture.

They describe the roentgenographic changes more fully as follows:

1. If examined soon after the onset of symptoms the bones will be found to be entirely negative and only swelling of the soft tissues will be noted.

2. After one to three weeks there will be a little periosteal fuzziness at the site of the beginning fracture; very close observation may show a minute line of fracture. Occasionally the fracture appears before the periosteal reaction is seen.

3. A little later the periosteal shadow will become more distinct and circumscribed and it will be noted that this callus is overabundant for the size of the bone involved and the size of the fracture. At this time the fracture usually can be seen distinctly and will be found to have an irregular outline.

4. The fracture next shows signs of union and the callus is more dense and well circumscribed into a spindle shape. At this stage and in the preceding one this condition has been mistaken for a sarcoma which it simulates to some extent.

5. Roentgenograms taken six months later will show solid union with absorption of the excess callus. The shaft will appear normal except for a small amount of residual cortical thickening.

Displacement of the fragments of these fractures is very unusual. This is explained, probably, by the fact that the fracture is produced gradually, without violence to separate the ends, and that the periosteal thickening and early callus formation are present simultaneously or preceding the actual dissolution of the bone. Very rarely the fracture appears before the periosteal thickening.

Strapping, arch supports, and physiotherapy lessen the pain and shorten the period of disability. With rest, hot applications and relief from weight-bearing before the fracture has actually occurred, the condition may be arrested during the stage of preliminary swelling.

The roentgenograms which are reproduced show the successive stages of the condition.—*R. S. Bromer.*

BLOOD AND LYMPH SYSTEM

LOPO DE CARVALHO, and EGAS MONIZ. The visibility of the pulmonary vessels (angiopneumography). *Acta radiol.*, 1933, *14*, 433–452.

After many experiments on rabbits, dogs and monkeys, the authors succeeded in demonstrating the vessels of the lungs roentgenologically in man. A 120 per cent solution of sodium iodide is introduced into the right auricle of the heart by passing an opaque sound into one of the arm veins and pushing it along until it reaches the auricle. The passage of the sound is followed up by screen examination. The sound, which has been sterilized and kept in a sterile solution of 10 per cent sodium citrate, is introduced slowly, a small amount of physiological salt solution being injected at the same time by means of a syringe attached to the outer end of the sound, to facilitate the passage of the sound and prevent the formation of clots inside it. After the sound is introduced the roentgen film is placed against the anterior wall of the patient's thorax and the roentgeno-

gram taken. The syringe with which the physiological salt solution was injected is replaced by one containing the sodium iodide solution and the patient is told to take a deep breath and then remain absolutely still; 6 to 8 c.c. of the opaque solution is injected rapidly. The other syringe is then reattached and a little physiological salt solution injected to wash out the last of the iodide solution, and the sound is then withdrawn gently.

The examination is not at all disagreeable or painful to the patient. At most he has a slight attack of coughing at the end of the injection and sometimes a slight headache which does not last long.

A comparison of simple roentgenograms with angiopneumograms shows the value of the method in the diagnosis of pathological conditions in the lungs. A series of illustrative roentgenograms and angiopneumograms is given.—*Audrey G. Morgan.*

Conte, E., and Costa, A. L'angiopneumografia. (Angiopneumography.) *Radiol. med.*, Oct., 1933, *20*, 1301–1314.

This name is applied to the injection directly into the heart of an opaque substance which passes into the lesser circulation and renders the pulmonary vessels visible. The opaque medium is introduced into the heart through a small sound which is passed into one of the veins of the arm and pushed along until it reaches the heart. Iodides are used for the injections, particularly sodium iodide. The author has found a hypertonic solution of abrodil a very good medium. Enough iodide is added to bring the iodine content of a 10 c.c. vial up to about 6.5 gm. iodine. This amount is well borne and gives a good image of the arteries of the lungs.

The method has been used so far chiefly in normal subjects as it is still in the experimental stage. It is believed, however, that it will prove useful in demonstrating changes in the distribution, course and arrangement of the vessels of the lungs, in showing zones of hyperemia, congestion and ischemia and in making a differential diagnosis of cysts and tumors in the lungs and mediastinum. In cases of tuberculosis without clinical symptoms the author found characteristic pictures in cicatrized zones and in zones of active congestion.

The method is contraindicated in cases of heart disease and particularly in cases in which the lesser circulation is overburdened. A number of illustrative roentgenograms are given.—*Audrey G. Morgan.*

ROENTGEN AND RADIUM THERAPY

Frimann-Dahl, J., and Forsberg, Ragnar. Roentgen treatment of xanthomatosis. *Acta radiol.*, 1933, *14*, 506–511.

The authors describe the roentgen treatment of a case of xanthomatosis that has been under treatment for two years. The technique used was that commonly used in the treatment of inflammation, with 0.5 mm. copper filter, 40 cm. distance, 160 kv., 4 ma., and 150 r at each treatment. The defects in the skull were irradiated in 1930. On roentgenograms taken two years later the changes in the skull bones are so slight that they would probably pass unnoticed if their presence were not known. Whenever new localizations of the disease were detected in the bones roentgen treatment was immediately applied with very favorable and, as a rule, immediate results. There has been regeneration of bone substance in the xanthomatous areas. In addition to the local improvement there has been a striking improvement in general health. The symptoms of intracranial pressure have disappeared, the patient has grown and blood cholesterol has been reduced to normal. At present the patient is practically free of symptoms.—*Audrey G. Morgan.*

Foster, John H. Papillomatosis laryngis. *South. M. J.*, July, 1933, *26*, 625–630.

By the term papillomatosis laryngis is meant the condition appearing in early childhood, sometimes congenital, characterized by the occurrence of multiple papillomata on the mucous membrane of the larynx and adjacent parts, which growths have a marked tendency to recur after removal and to be transplanted to neighboring parts. In contrast to the adult type of the condition, it is locally malignant. Low tracheotomy should be performed in every case as a preliminary step to any other mode of treatment. While radium will undoubtedly cause disappearance of the growths, as yet no technique has been developed which will insure a good result without danger of necrosis of the cartilages or serious synechiae or scar formation. The roentgen ray offers the best means at the present time for treatment of the condition. Three cases in which roentgen irradiation caused a prompt and thorough disappearance of the growths with no injury to the

larynx are reported. The technical factors employed were 100 kv., 7 inch spark gap, 5 ma., 18 inch distance, 4 mm. aluminum filter with exposure to alternating sides for ten minutes on three occasions.—*W. R. Brooksher.*

COHEN, LEE. Treatment of intractable laryngeal papilloma in adults, with case report. *South. M. J.*, July, 1933, *26*, 621–625.

In adults papilloma of the larynx shows a comparatively slight tendency persistently to repullulate, yet these few recurrences are important in consideration of treatment because of the possibility of economic loss through voice impairment or of malignancy supervening. Surgical extirpation of the growths is universally recognized as the first step in the cure, no matter what procedure may be later employed to prevent recurrence. Among these procedures are the use of various chemical substances, the actual cautery, fulguration and irradiation. There is some prejudice against irradiation with radium and roentgen rays because of the perichondritis which has followed their use. Good results that have been obtained without any untoward reaction by Hickey, New and the author from the use of radium and by Blondeau, Spira, Gray, Dahman, Blau and Thrane with the roentgen ray force the conclusion that, with the present better understanding of dosage, with proper filtration, such disasters need no longer occur; that it is entirely justifiable to make use of this agency in those intractable adult cases which have repeatedly suffered recurrence in spite of all other measures employed. Any attempt at cure by the use of irradiation, without first removing the growth surgically, is a serious mistake. Papilloma is highly resistant to irradiation, whereas the laryngeal cartilages have a very low resistance; consequently the massive doses required for destruction of the papilloma will certainly end in disaster for the cartilages. On the other hand, mild doses, which do not harm the cartilages, seem sufficient in their effect upon the underlying tissue to make recurrence less likely, and in many instances, prevent it entirely. Application of irradiation from without is considered the method of choice. The portal of entry of the rays through the skin should be accurately adjusted, however, in order to take in the larynx only. Only an experienced radiologist, well versed in the physiological effects and the dangers from faulty technique, should be entrusted with the delicate task. Two cases are reported in detail, one showing the destructive action of massive doses of radium applied within the larynx and the other, the excellent results from irradiation following the proper dosage of roentgen rays used from without.—*W. R. Brooksher.*

GOSSET, and WALLON, E. De la curiethérapie dans le cancer des joues et des lèvres. (Curie therapy in cancer of the cheeks and lips.) *J. de radiol. et d'électrol.*, 1933, *17*, 305–315.

After briefly considering the anatomic distribution and the clinical appearance of cancers of the cheeks and lips, the authors deal in detail with therapeutic procedures and the results obtained. The material includes 11 cancers of the cheek, with a cure of 27 per cent, and 20 cancers of the lips with a cure of 75 per cent. The procedure of therapy is briefly as follows: In cancers of the cheek radium puncture forms the method of choice in the fungating types and surface radium application in the infiltrating types. In cancers of the lips radium puncture is used in all cases. The treatment in both instances is spread over a period of about eight days, aiming to produce a prolonged irradiation so as to affect all the cells during the stage of their maximum radiosensitivity. The adenopathy is treated surgically, usually fifteen days after the irradiation, if the operation is feasible and by external irradiation if adherence to the deeper structures or a mixed secondary infection has already taken place so that operation cannot be performed.

It is the authors' belief that the reason why cancers of the cheek lead to poor results must be attributed to the fact that these cases usually come later for treatment than cancers of the lip.—*T. Leucutia.*

VON MEYSENBUG, LUDO. X-ray therapy of pertussis. *South. M. J.*, June, 1933, *26*, 565–568.

Based upon a review of the literature and 21 cases personally observed, von Meysenbug advances the opinion that the roentgen ray is the most effective agent for relieving the distressing symptoms of pertussis, shortening the course and preventing the dangerous complications which are often encountered. In his cases the treatments were usually given at weekly or ten day intervals, employing the following factors: 140 kv., 5 ma., 20 inch distance, 0.25 mm. copper and 1 mm. aluminum filter, 5 minutes.—*W. R. Brooksher.*

Delherm, Louis, and Nilus François. Roentgenthérapie lombo-sacrée et périphérique appliquée à la sciatique. (Lumbosacral and peripheral roentgen therapy applied to sciatica.) *Presse méd.*, Oct. 21, 1933, *41*, 1625–1626.

In 1908 Babinski presented before the Society of Neurology of France a case successfully treated by one of the authors (Delherm) with radiation therapy of the lumbosacral region. In 1911, Babinski, Charpentier and Delherm reported 4 additional successful cases, of which 2 were treated by the lumbosacral and the other 2 by a combination of lumbosacral and peripheral irradiation. Since that time numerous other cases have been reported so that one may now say that the method has become classical.

In this article the authors present the results in a total of 297 cases comprising only the so-called rheumatic sciatica, treated by roentgen therapy. All of them were treated by lumbosacral irradiation first, the following being the rsults: aggravation, 7 cases (2 per cent); stationary, 50 cases (17 per cent); amelioration, 79 cases (25 per cent); cure, 161 cases (55 per cent). In 56 cases of aggravation, stationary and amelioration, peripheral irradiation was supplanted later with the following results: failures 9, ameliorations 12, and cure 35, thus giving the following final results of the entire group: aggravation, 6 cases (2 per cent); stationary, 33 cases (11 per cent); amelioration, 62 cases (22 per cent); cure, 196 cases (65 per cent). The irradiation was carried out with small repeated doses by administering, from 1904 to 1911, one H and later 300 to 400 R, that is 1½ H to 2 H, per seance, until a total of 1,200 to 1,600 R per series was reached, distributed over ten to fifteen days. The quality of the roentgen rays was 20 to 25 cm. spark gap, filtered by 5 to 8 mm. Al. The fields in case of the lumbosacral irradiation covered D_{10} to L_3, and L_4 to S_3 (two fields on each side) and in case of peripheral irradiation the region of the sacroiliac articulation, the emergence of the sciatic nerve underneath the fesseter muscle, the popliteal groove and various painful points along the nerve. A bibliography of 23 articles is included.—*T. Leucutia.*

Scharnagel, Isabel M. Treatment of malignant melanomas of the skin and vulva at the Radiumhemmet, Stockholm. *Acta radiol.*, 1933, *14*, 473–490.

The author gives a brief review of the literature on the methods and results of treatment of malignant melanomas of the skin and discusses the 70 cases that have been treated at the Radiumhemmet from Jan. 1, 1921 to July 1, 1930. The diagnosis of malignant melanoma was confirmed histologically in all but 6 cases, in which the patients died. Three of the patients had distant metastases on admission to the hospital and 33 had metastases in the regional lymph nodes.

In 45 of the cases electroendothermy was used in combination with irradiation, 4 were treated with electroendothermy alone and 21 with irradiation only. The latter cases had inoperable or advanced lesions which may account for the low percentage of cures. The percentage of cures was highest in the cases given combined treatment and the author concludes that this is the method of choice. The rate of actual cure for the whole number of cases was 45.7 per cent for the three year period, 38.7 per cent for five years and 35 per cent for ten years. The prognosis is not hopeless even in cases in which the regional lymph nodes have been invaded. Three patients are living and well after dissection of such nodes and irradiation, and this method is therefore recommended for operable metastases also.—*Audrey G. Morgan.*

Nilsson, Folke. Erfahrungen über Adenocarcinoma colli uteri. (Experience with adenocarcinoma of the cervix of the uterus.) *Acta radiol.*, 1933, *14*, 283–330.

The author reviews a material of 26 cases of adenocarcinoma of the cervix treated primarily with radiotherapy at the Radiumhemmet in Stockholm from 1916 to 1925. Fifty-three per cent of these cases were operable. Clinical cure was brought about in 64 per cent of these and in 41 per cent of the inoperable cases. The percentage of five year cures for the whole series was 19.23, for the operable cases 28 and for the inoperable ones 8. There were local recurrences in 50 per cent of the cases, and gland recurrences and recurrences in the connective tissue of the pelvis in 50 per cent.

Adenocarcinomas of the cervix show a marked tendency to become generalized. The typical and most frequent form of adenocarcinoma of the cervix is characterized by a long initial period free of symptoms. This, together with its tendency to dissemination, accounts

for the low percentage of permanent cures. There is nothing to indicate that they are not radiosensitive or that larger doses are necessary than in other forms of tumor. Nor is there any reason to expect that surgery would produce any better results in these cases than radiotherapy alone.—*Audrey G. Morgan.*

MISCELLANEOUS

EDITORIAL. The position of the radiologist and radiotherapist in the hospital scheme. *Am. J. Cancer*, Feb., 1933, *17*, 462–465.

Recently there has been a great deal of discussion among radiologists as to the position in the hospital scheme which radiology and radium therapy should occupy. Hospital authorities are apt to take the point of view that a radiologist is employed by an institution solely to prepare films for diagnostic purposes, and to write short objective reports on his findings. They attempt to get a man who, after deducting the expenses of running the department, will share in the profits from the diagnoses which he makes. The second procedure is to pay a salary and divide the income when the income exceeds the salary, or finally, a larger salary may be paid and all the proceeds obtained from the patients taken by the hospital. Under these circumstances the radiologist is little more than a glorified technician.

The causes of this situation are manifold and part is due to the fact that only a few radiologists are fitted for the work which they have taken up. They have been men who have failed in internal medicine and surgery. The clinical interpretation of such a man is obviously not accepted by his colleagues. Radiologists are in essentially the same position as pathologists, and as were surgeons in the middle ages. Radiologists, as a rule, are never advanced into the clinical services as is done in Europe, especially Germany.

A remedy for this situation lies in the hands of the radiologist and the change will occur just as soon as radiology develops enough to draw to it men of great personality. Part of the difficulty has been the misunderstanding of the proper allocation of radiology and radium therapy. Theoretically, radiology should be done by men who have had good training in medicine and surgery. The technical work should be done by the technician. The radiologist should be required for interpretation and clinical study.

Radiologists should have an opportunity to go to autopsies on cases which they have studied. The radiologist should be a useful person in the operating room following up cases which he has studied. In that way it would be his business to develop his medical, surgical, and pathological knowledge, and when he has arrived at that position, he will be a welcome member of the medical and surgical conferences, and his position in the medical school will be secure.

The difficulty with the radiologist has been that he has attempted therapy without sufficient training. According to the author, there are three divisions of radiology. The first is primarily concerned with diagnosis. The second is deep therapy which is predominantly a part of surgical treatment and should be done by men trained in surgery. The third is superficial dermatological therapy.

The author feels that it would be better if the radiotherapist is a member of the surgical staff and had allocated to him the care of all inoperable cancers in any institution, in addition to the therapy of the cervix, of the fibromyomata of the uterus, and many of the skin and oral cavity tumors. He may work with one of his surgical colleagues curing the local lesion of the tongue, or lip, with radium or roentgen rays, while the surgeon removes the nodes of the neck, etc.

The third variety of radiation therapy belongs to the dermatologist and should be limited to the therapy of non-malignant disease.

Obviously, the above remarks are directed toward the hospital of sufficient size as would warrant specialization. The small institutions would still have to have the inferior type of man in radiology just as the surgeons and medical men are inferior to those in large institutions. The author states that one of the reasons for appeals of cancer institutes in special hospitals is because the automobile has now made it possible for the population to get in communication with institutions where proper therapy is undertaken by men who have had long training in radiation therapy and surgery.—*E. P. Pendergrass.*

POITTEVIN. Nouvelle méthode radio-kymographique. Description de l'appareil. (New roentgen kymographic method. Description of the apparatus.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1933, *21*, 344–347.

Kymography, as is known, is used for the roentgenographic tracing of the movements of various organs. For this purpose a diaphragm provided with a slit is placed in front of the mobile point to be studied, the slit always having a direction parallel to that of the movement at the point. The film which is situated between the mobile point to be examined and the slit is then kept in motion during the actual registration so that the successive positions of the point are traced graphically, this corresponding to the exact movement of the point to be considered. A kymogram may be obtained also by moving the slit instead of the film, in which case a tracing of a succession of points is obtained.

Kymography is not a new procedure, Gött and Rosenthal having obtained good tracings through a single slit a number of years ago. More recently Stumpf devised a diaphragm provided with several slits spaced at about 12 mm. from each other. Finally Cignolini constructed a diaphragm containing juxtaposed bands in which one may place a slit at convenience.

The apparatus presented by the author embodies certain innovations. Thus, the diaphragm consists of three compartments of identical dimensions, the central part being mobile and the two others fixed. Fluoroscopic screens, roentgenographic cassettes and kymographic diaphragms may be placed in any of the compartments according to requirement. In this manner the apparatus permits the following operations: simple roentgenoscopy, simple roentgenography, kymography with a fixed diaphragm and kymography with a mobile diaphragm. One may also perform an exact roentgenoscopic or roentgenographic centering with a special diaphragm containing opaque wires which correspond to the transparent slits of the kymographic grid. In this way the point to be analyzed is exactly centered by roentgenoscopy and then following an interchanging of the screen and the kymographic diaphragm the movement of the point is traced on the roentgenogram. The displacement of the grid or of the film, that is, the length on which a kymographic curve may be traced, is either 15, 30 or 45 mm. The duration corresponding to this displacement extends from 1 sec. to 20 to 30 sec. The apparatus may function in three positions, two of which are used with the patient standing (the direction of the movement being either vertical or horizontal) and one with the patient lying down. Finally, the inclusion of a periodic obturator permits the chronometric inscription of the time element on the kymographic curve. A photograph of the apparatus is included.—*T. Leucutia.*

Delherm, Thoyer-Rozat, P., Fischgold and Codet. Abrégé de la nouvelle technique radio-kymographique. (Résumé of the new roentgen kymographic technique.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1933, *21*, 342–344.

The essential point constituting the originality of the apparatus which the authors present consists in the independence of the grid, which is replaced by a play of grids, permitting the realization of more or less spaced inscriptions on various sizes of film (from 15 to 45 mm.) with varying duration. Thanks to these modifications the kymographic technique becomes a very simple one so that it may be adapted to any organ, to various pathologic lesions and even to tracing of the various individual characteristics. The authors discuss the variation in procedure which is required for the kymographic tracing of (A) the heart, great vessels, mediastinum, (B) lungs, diaphragm, and (C) digestive tract, and arrive at the conclusion that as a whole the roentgen kymographic method is greatly superior to roentgen cinematography, especially for the following reasons: the roentgen tube is submitted to a stress which is well stood under the present technical development, the electrical constants not exceeding those usually employed in roentgenography of the lateral spine; the skin of the patient is not subjected to any damage, the total dose of a roentgen kymographic examination of the heart, for example, representing 35 R; the expense connected with the film is a minimum one, one or two films of 30×40 cm. being sufficient.—*T. Leucutia.*

Delherm, L., Bordet, Émile, Thoyer-Rozat, P., and Fischgold, H. Courbes de radiokymographie de la révolution cardiaque. (Roentgen kymographic curves of the cardiac revolution.) *Bull. et mém. Soc. de radiol. méd. de France*, 1933, *21*, 651–660.

The term roentgen kymographic curve is used to differentiate it from the usual kymographic procedures. This is not done to underestimate in the least the method of Stumpf, which in fact forms the basis of the authors' method, but it was felt that the simultaneous

registration of the beats of several predetermined points of the cardiovascular contour would help to bring about a better estimation of its function. The registrations represent true curves which are useful both to the physiologist and the physician. In previous communications the authors have shown how much the roentgen kymograms resemble in their ensemble intracardiac pressure curves and mechanical tracings; yet they differ in detail. It is only through comparison with the other graphs that correct interpretation is obtained and therefore it was decided to maintain the nomenclature of the old methods for the specification of the various peak points of the curves.

The authors describe in detail, using quite a number of roentgen kymographic curves for illustration, the appearance (I) of the normal curves which are subdivided into (A) ventricular, (B) aortic and (C) auricular; (II) the variation from the normal, these including the variations at the left border of the middle arc and of the right border of the heart; and (III) certain pathologic curves referring chiefly to disorders of rhythm (bigeminy and auricular fibrillation) and cardiac insufficiency.

The following conclusions are reached: (1) The roentgen kymographic curve represents the activity of the walls proper during the course of the cardiac revolution. (2) It gives by one single procedure information of cardiography, phlebography, and sphygmography. (3) It is superior to the graphic methods since it reproduces without inertia the movements of the heart from their beginning to their end. (4) The positive roentgen kymographic peaks correspond to a "retreat" movement of the walls due either to contraction of the myocardium or evacuation of the cavities or to transmitted pulsations. The negative peaks are the result of a movement of expansion indicating either dilatation or repletion or finally transmitted pulsations. (5) The normal curves show either a pure type or a complex type. Among the complex types the authors identify the arterial type for the left auricle, a transmitted ventricular type for the right auricle or more exactly for the right border of the heart, and an essential ventricular type. (6) In the arrhythmias, especially in extrasystole and fibrillation, roentgen kymography though registering satisfactorily these troubles does not furnish as much information as electrography. In flutter the roentgenographic inscriptions reveal a phenomenon which cannot be found with any other graphic method: tremulation of the auricular walls is propagated to the ventricles, arteries and vena cava. (7) Finally, in ventricular insufficiencies the roentgen kymographs register the particular sinking in of the plateau of evacuation, the appearance of which is that of a more or less regular M. (8) In general conclusion, one may say that roentgen kymography furnishes information of a mechanical nature which is entirely specific and new.—*T. Leucutia.*

BERNARD, LÉON, PELLISSIER, and SILBERMANN. La radiokymographie en pratique phtisiologique. (Roentgen kymography in phthisiologic practice.) *Presse méd.*, Dec. 20, 1933, *41*, 2053–2057.

The authors used kymography for study of the movements of the tuberculous lungs to estimate the efficacy of collapse therapy on the diseased lung. It is stated that the method has been applied only for a few months and that therefore the article must be considered as only preliminary. The Stumpf apparatus was used with the modifications introduced by Delherm and his coworkers (see former abstracts in this Journal). After a lengthy discussion of the interpretation of the kymograms and the various clinical applications, the authors arrive at the following general conclusions: (1) the method permits the graphic tracings of the movements of diseased lungs and their lesions, of the diaphragm and of the mediastinum in phthisiologic practice. (2) Until now the authors used kymography chiefly for the control of the results of collapse therapy produced either by artificial pneumothorax or phrenicectomy, the method permitting more precise information than obtained from ordinary roentgenography and roentgenoscopy. (3) They are convinced, however, that other multiple applications of kymography will find their place in phthisiology, such as functional control of the diaphragm, evaluation of the results of a thoracoplasty, mobility of the cavity, and so on. One may even use kymography for study of the effect of collapse therapy on the function of the heart.

Roentgen kymography will never replace ordinary roentgenography or roentgenoscopy but as a supplementary method it will become invaluable.—*T. Leucutia.*

ADAMS, W. E., and LIVINGSTONE, H. M. Lobectomy and pneumectomy in dogs. *Arch. Surg.*, Nov., 1932, *25*, 898–908.

The interest of the authors in experimental lobectomy and pneumectomy was aroused by the discovery of a safe and reliable method of permanently closing large bronchi. A review of the literature on this subject reveals the appalling mortality of these operations to be due primarily to either pleural infection or reopening of the bronchial stump (or both) subsequent to operation. The idea presented itself that these complications would be obviated by "closing the stump" before removal of the pulmonary tissue.

Such closure of the bronchi is effected by cauterization of the entire circumference of the bronchial wall by the application through a bronchoscope of a 35 per cent solution of silver nitrate. The procedure may be repeated if stenosis is not complete following a single application. The stenosis usually occurs within two weeks and is always accompanied by 100 per cent atelectasis of the obstructed pulmonary lobe or lobes. When an entire lung is to be removed, the primary bronchus to that side is stenosed.

Using this method one or two lobes were removed in 20 dogs without a single death and all pulmonary lobes on one side were extirpated in 8 dogs with the death of 1 animal. In this manner the usual difficulties of associated pneumothorax and pleural infection have been obviated. Dogs killed from two months to a year after the operation showed obliteration of the pleural cavity by compensatory emphysema and mediastinal displacement.—*J. R. Andrews.*

Segre, Mario. Di un nuovo dispositivo per la stereoradioscopia e la stereoradiografia. (A new apparatus for stereoroentgenoscopy and stereoroentgenography.) *Radiol. med.*, Sept., 1933, *20*, 1206–1211.

The author describes the illustrates an apparatus that he has devised for use in stereoroentgenoscopy and stereorentgenography and discusses the technique of its use. It is made up of two roentgen tubes located in such a way that the rays emitted from each of them after traversing the body or object to be examined strike the screen or plate on the opposite side of a plane passing between the two tubes, thus producing stereoscopic images.

This apparatus is adapted particularly for studying small organs which are not very thick and are very opaque so that they stand out distinctly from the surrounding parts, or for studying limited parts of larger organs. As it is adapted for studying organs in movement the author believes it will prove of special value in investigating the morphology of the bulb of the duodenum and making an early diagnosis of ulcers of the duodenum; also in diagnosing the initial stages of infiltrations of parts of the digestive tract (esophagus, stomach, intestine), as such tracts can be seen in relief without superposition of the opposite wall. It should also prove useful in observing the function of the kidney pelvis and ureter.—*Audrey G. Morgan.*

Sandera, R. Ein Gerät zur Einstellung typischer und atypischer Fernaufnahmen. (An apparatus for focussing typical and atypical distant roentgenograms.) *Acta radiol.*, 1933, *14*, 512–521.

This is a technical description of an apparatus for focussing distant roentgenograms under typical and atypical conditions. It can be mounted on any tube or universal stand. Focussing is easy and accurate and can be reproduced when it is desired to take further roentgenograms later. The apparatus is illustrated and its use described in detail.—*Audrey G. Morgan.*

Frimann-Dahl, Joh. A new projection for the roentgenology of the optic foramen. *Acta radiol.*, 1933, *14*, 470–472.

The author describes a new method of taking roentgenograms of the optic foramen which is simple, rapid and accurate, requires no special apparatus and eliminates the necessity for any adjustment of the tube. The patient lies on his back instead of on his face as in all former methods. The ray is centered on the middle of the pupil.

Photographs of the application of the method are given and roentgenograms of a normal optic foramen and of one in which advanced destruction has taken place as a result of increased intracranial pressure.—*Audrey G. Morgan.*

Capua, Antonio. Dimostrazione dei linfatici della pleura mediante iniezione di Thorotrast. (Demonstration of the lymphatics of the pleura by means of intrapleural injections of thorotrast.) *Radiol. med.*, July, 1933, *20*, 905–911.

Roentgenograms are reproduced which illustrate the thoracic cavity of a dog after about 5 c.c. of a solution of thorotrast had been in-

jected into its right pleural cavity. They show a distinct contrast picture of the lymphatic system of the pleura as well as a part of the external wall of the pericardium and the vessel peduncle. They also show the communication between the lymphatic system of the right pleura and that of the left and between the pleural and abdominal lymphatics.

The author then injected 10 c.c. thorotrast into the bronchial tree by way of the trachea. The opaque fluid collected in the posterior basal parts of the lungs, penetrating to the smallest branches of the bronchi and giving a diffuse and almost homogeneous shadow. Roentgenograms taken fifteen days later showed that the opaque substance had not been eliminated; it remained in its original position and had not entered the lymphatic circulation. The peritracheal and peribronchial lymph glands were not impregnated with the contrast medium; only a few of those at the bifurcation showed distinct shadows.—*Audrey G. Morgan.*

ZACHRISSON, CARL GUSTAF. A new suspension medium for barium sulphate in examination of the digestive tract. *Acta radiol.*, 1933, *14*, 331–334.

The author recommends the use of a warm 1 per cent agar solution which slowly coagulates to a gel at 40°C. as a cheap and practical suspension medium for barium sulphate in examination of the digestive tract. The formula is as follows:

500 c.c. hot 2 per cent agar solution
500 c.c. water
600 gm. barium sulphate (chemically pure).

The agar dissolves over a water bath in about an hour. Barium sulphate is mixed with the hot water and the hot agar solution is added so that a homogeneous suspension is obtained. This should be kept in thermos bottles to avoid coagulation. It must be shaken before using and should be used at a temperature of 45°–50°C.

A somewhat smaller amount of barium sulphate is used for injections into the colon, 500 gm. per 1000 c.c. fluid and 0.5 per cent agar solution. The material is injected at a temperature of about 50°C. so that it rises quickly in the intestine. A funnel surrounded by a metal hot water jacket is used to prevent coagulation of the opaque mixture outside the body. The funnel and attached rubber tube are thoroughly rinsed in hot water before using.—*Audrey G. Morgan.*

MILESI, GIUSEPPE. Contributo alla conoscenza dell'azione biologica delle radiazioni Roentgen. (Study of the biological action of roentgen rays.) *Radiol. med.*, 1933, *20*, 911–918.

The author describes experiments made on rabbits in an attempt to determine whether roentgen rays modify the production of antibodies. The rabbits were irradiated with moderate doses of rays, about ½ of a skin erythema dose, after having been given intravenous injections of sheep's corpuscles and the serum titrated. A few hours after the irradiation the serum was titrated again and the reticuloendothelial system of the animals blocked with trypan blue. For controls he used rabbits, all of which had been given injections of red blood corpuscles; some of them had not been irradiated and some of them had been irradiated but not blocked. The experiments showed that the irradiation caused an increased production of hemolysins, confirming the belief that roentgen irradiation has a stimulant action on processes of immunization. The intravenous injections of trypan blue, on the contrary, caused a marked decrease of hemolysins. The trypan blue injections caused less decrease of hemolysins in the rabbits that had been irradiated than in the ones that had not been irradiated.—*Audrey G. Morgan.*

BERNSTEIN, MAURICE A. Experimental production of arthritis by artificially produced passive congestion. *J. Bone & Joint Surg.*, July, 1933, *15*, 661–673.

This paper is a report on the experimental production of the lesions of chronic arthritis and the formation of new bone in dogs by means of artificially produced venous stasis. So many factors are involved in the etiology of hypertrophic arthritis, or of any type of arthritis, that any attempts directed toward the discovery of any proved causative influence is valuable.

Changes of a regenerative nature were produced in the spines and of a degenerative nature in knee joints in dogs. The changes in the former were cartilage proliferation and new bone formation. In each of 3 dogs the changes took place in the intervertebral spaces and in the fibrosus annulus intervertebralis. Islands of cartilage spaces were seen in the bodies at their peripheries and below the intervertebral discs. In the spine of one dog there was a proliferation of cartilage into the body of the third lumbar vertebra and formation of osteoid

tissue. In 1 dog masses of new bone were found on the anterior surfaces of five lumbar vertebrae and one thoracic vertebra. In this dog young osteoid tissue and new bone were present in the body and extended beyond the anterior surface. The changes were more pronounced in the lumbar vertebrae and corresponded to the region of the ligated veins.

Microscopically there was shown a proliferation of cartilage cells and these cells were distributed irregularly through the bone trabeculae. Osteoblasts were present on the borders of the osteoid tissue, and in other regions nests of osteoclasts were evident. The marrow spaces contained fat, and the hemapoietic tissue was decreased in amount. In other regions the trabeculae appeared to be normal with some increase of the intercellular elements.

Bernstein kept the dogs of this series of experiments alive for practically the same length of time, two years, so that the bone changes were of the same duration. Two were kept alive for a shorter period, two to six months, so that in these dogs the processes were not so far advanced as in the others. He deduces from the experiments that proliferation, or rather new bone formation, resulted from venous stasis. The control animals showed no such changes.—*R. S. Bromer.*

Banner, E. H. W. High-voltage generators for x-ray apparatus. *Brit. J. Radiol.*, 1933, *6*, 360–377.

Methods of generating high voltages for the excitation of roentgen tubes are discussed from an electrical engineering viewpoint, dealing with efficiency and measuring methods. Direct current supplied from valve tube rectifiers with condensers is concluded to be the best from the electrical aspect and standardization is suggested on this or some similar circuit, to the advantage of both manufacturer and user. The Greinacher circuit using two valves and two condensers is considered in detail and test results are given on an experimental low-voltage circuit of this type. From these results are deduced some points in design and an outline specification for a continuous voltage plant for 90 kv. and 100 ma. Other design features discussed include voltage selection in 3 or 4 steps, control by tappings on the transformer primary, roentgen tube current setting by filament rheostat, exposure controlled by a watt-second relay to minimize the effect of line voltage fluctuation.—*L. S. Taylor.*

Mayneord, W. V., and Roberts, J. E. Measurements of high-voltage x-rays. *Brit. J. Radiol.*, 1933, *6*, 321–344.

A comprehensive set of roentgen-ray intensity and quality measurements are described for voltages up to 370 kv. ("constant potential"). A thimble type of ionization chamber was used with the evident assumption that the wall effect was negligible over the range of qualities used. Curves show the variation in output as functions of voltage and filtration for both copper and lead. Intensity measurements made in a water phantom corroborated earlier findings. A very small difference in percentage depth dose is found between 200 kv., 0.5 mm. copper and 370 kv., 5.0 mm. copper, being only 4.4 per cent at 75 cm. focus-skin distance and a field area of 50 cm. Using larger fields, the change was of the order of 8 per cent. The general conclusion is that the percentage depth dose changes an almost negligible amount with quality over the ranges studied. A description of their protective measures is included.—*L. S. Taylor.*

Forssberg, Arne. Der Zeitfaktor in der biologischen Wirkung von Röntgenstrahlen. (The time factor in the biological action of roentgen rays.) *Acta radiol.*, 1933, *14*, 399–407.

Experiments were made to determine the importance of the time factor in the irradiation of three different kinds of unicellular algae and on the pupae of *Drosophila*. In the experiments with algae the intensity varied from 22 r/min. to 3,235 r/min. and the doses from 5,000 to 10,000 r. The corresponding values for the *Drosophila* pupae were 5 r/min. to 3,235 r/min. and 2,000 r. The injurious effect on the algae was determined partly by the percentage o mortality and partly by the delay in cell division. The two methods gave uniform results, as the effect at first rapidly increased with increased intensity and apparently reached its maximum at about 1,620 r/min.

The experiments on *Drosophila* pupae showed that the maximum effect was reached at about 20 r/min. With intensities of from 22 r/min. to 3,235 r/min. the effect was about the same.

The experiments therefore show that with constant quantity and quality of irradiation there is a rapid increase of the effect up to a certain point and after that no noticeable in-

crease or decrease in the injurious action.—*Audrey G. Morgan.*

OVERGAARD, KRISTIAN. An apparatus for marking the desired direction of the roentgen ray. *Acta radiol.*, 1933, *14*, 427-430.

A simple apparatus is described and illustrated which makes it easy for the roentgenologist to mark for the guidance of his staff the desired direction for the rays in deep therapy.

It consists of a flat rectangular metal plate 3 x 10 cm. in size, to one of the long sides of which another triangular plate is riveted. A bolt that can be turned passes through the upper corner of the latter plate and an indicator rod passes through a hole in this bolt just in front of the plate. This rod can be pushed backward and forward longitudinally. By turning the nut the indicator can be fixed at any desired inclination to the horizontal plate and at the same time it can be moved in its own longitudinal direction in such a manner that its point reaches all the way to the horizontal plate. There is a small notch in the joined plates vertically below the axis of the indicator.

When it is desired to indicate some line of irradiation other than that at right angles to the surface of the part to be irradiated the apparatus is placed with its base resting on the part. It is then moved about until the triangular piece lies in the plane of the central ray's projection on the body. The indicator is then turned so as to lie in the desired direction of the central ray and is pushed along lengthwise until its point reaches the skin. The point where the indicator reaches the skin is then marked with an arrow-head and an x is made on the skin at the place corresponding to the notch in the plate. When the line of irradiation has been marked off in this manner the assistants will later be able to read it by means of the same apparatus. It is only necessary to place the apparatus exactly as before with the x corresponding to the notch; the indicator is then turned and pushed along until its point touches the plane of the skin at the tip of the arrow-head. The indicator will then be pointing exactly in the line of the desired irradiation.—*Audrey G. Morgan.*

SUBJECT INDEX TO VOLUME XXXII

(abs) = abstract (E) = editorial

Abscess, pulmonary, in children (abs), 267
unusual case of retropharyngeal-esophageal, diagnosed by roentgen examination (abs), 573
Adenitis, cervical, roentgen treatment, 293
Adenocarcinoma of cervix, experience with (abs), 831
Adenomas of cervix, radiotherapy of (abs), 144
Allergy, food, roentgen studies of patients with gastrointestinal (abs), 271
Aluminum, thicknesses of, to be used in addition to copper filters, 92
American Board of Radiology, 252, 817
American College of Physicians, notice of 1935 meeting, 104
American Radium Society, new officers, 253
American Roentgen Ray Society, annual meeting (E), 240; (E), 558
commercial exhibit, 249
new officers, 568
scientific exhibit, 563
scientific program of annual meeting, 245
Amyloidosis, pneumosilicosis and (abs), 706
Anemia, osteosclerotic (abs), 130
Aneurysm, aortic, with spontaneous pneumothorax (abs), 120
of pulmonary artery (abs), 268
Angiopneumography (abs), 261; (abs), 828; (abs), 829
its application in pulmonary tuberculosis (abs), 262
Antrum of Highmore, odontogenous sinusitis of (abs), 821
Apparatus for focussing typical and atypical distant roentgenograms (abs), 835
for marking desired direction of roentgen ray (abs), 838
new, for stereoroentgenoscopy and stereoroentgenography (abs), 835
new, for teleradium treatment at Radiumhemmet (abs), 292
plane surface applicator (abs), 138
roentgen, experimental study of voltage curve in (abs), 287
roentgen, high voltage generators for (abs), 837
Appendicitis, Stierlin's symptom in (abs), 124
Appendix, diverticula of, roentgen study of two cases (abs), 422
failure to fill, discussion of (abs), 125
rapid procedure of roentgen exploration of (abs), 422
Arteriography of extremities with thorotrast, technical considerations, 64
Artery, pulmonary, aneurysm of (abs), 268
Arthritis, chronic, clinical analysis of 350 cases (abs), 429
chronic, colon changes in, compared with other chronic diseases (abs), 423
experimental production of, by artificially produced passive congestion (abs), 836
hypertrophic, influence of age in experimental production of (abs), 430
Arthrokatadysis of hip joint (abs), 825
Arthropathy, tabetic (abs), 715
Atelectasis: See Lungs, massive collapse
Atrophy, progressive, of facial bones (abs), 709
Azygos vein: See Lungs

Barium sulphate, new suspension medium for, in examination of digestive tract (abs), 836
Barytes, pneumoconiosis in workers in (abs), 264
Basedow's disease: See Goiter, exophthalmic
Beta rays, secondary, clinical importance in radium treatment (abs), 292
Bile, limy (abs), 706
Bladder, carcinoma of, technique of suprapubic implantation of radon seeds in (abs), 275
Blastomycosis of bone (abs), 715
Blood picture, observations of, in roentgen irradiation (abs), 288
vessels, pulmonary, visibility of (angiopneumography) (abs), 828
vessels, roentgen demonstration in cadaver and living subject by means of umbrathor and thorotrast (abs), 133
Bone, and joints, metastatic infection of, as initial clinical manifestation of gastric neoplasms (abs), 823
blastomycosis of (abs), 715
endothelioma of (abs), 716
metastases to, from hypernephroma (abs), 128
perforation of, by splinter of wood, 555
post-traumatic acute atrophy of (E), 811
solitary juvenile cysts of, late results of operation in (abs), 432
syphilis of (abs), 426
tumors, irradiation in treatment of (abs), 274
Bones, facial, case of progressive atrophy of, with complete atrophy of mandible (abs), 709
Book Reviews
A Practical Treatise on Diseases of the Skin for the Use of Students and Practitioners. By Oliver S. Ormsby, 105
The Clinical Management of Horseshoe Kidney. By Robert Gutierrez, 105
Practical X-Ray Therapy. By Hugh Davies, 106
Les syndromes doulereux de la region epigastrique. By René A. Gutmann, 106
De Venarum Ostiolis 1603 of Hieronymus Fabricus of Aquapendente (1533–1619). Facsimile edition with introduction, translation and notes by K. J. Franklin, 405

Clinical Miscellany. By Members of the Staff of the Mary Imogene Bassett Hospital, Cooperstown, New York, 405
The Universe of Light. By Sir William Bragg, 405
Radiologie de la vesicule biliare. By Dr. Nemours-Auguste, 406
Ueber die Wirkungen der Röntgenstrahlen auf die Lungen. By Rolf Bull Engelstad, 406
Röntgenologische Studien über die traumatischen und habituellen Schultergelendverrenkungen nach vorn und nach unten. By Ivan Hermodsson, 406
Radiologic Exploration of the Mucosa of the Gastro-intestinal Tract. By the Cole Collaborators, 569
Röntgenologische Skelettstudien an menschlichen Zwillingen und Mehrlingen. By Franz Buschke, 569
BRAIN, encephalography in surgical lesions of (abs), 259
neoplasms of, and normal, effect of irradiation on (abs), 134
tumor of, with destruction of cranium, cured for five years by radiotherapy (abs), 435
BREAST, carcinoma, radium dosage and technique, 730
correlation of roentgen picture with histology in certain lesions of (abs), 706
BRONCHI, carcinoma (abs), 118
BRONCHOGRAPHY, serial, in early diagnosis of bronchial carcinoma, 757
use of iodized oil in, 763
BURSOPATHY, syphilitic, of Verneuil (abs), 427

CALCIFICATION in intestinal tuberculosis, 782
of costal cartilages in normal individuals and those with tuberculosis (abs), 112
CALCIUM stream as concerned with healing of fractures, 457
treatment of pain in cancer (abs), 434
CALCULUS, solitary intrahepatic, demonstrated by roentgen examination (abs), 126
CALDWELL LECTURE, 1934, 575
CANCER, calcium treatment of pain in (abs), 434
chronic cases, care and treatment of, 740
external, radiotherapy (abs), 136
newer concepts in treatment of, based on research (abs), 434
of lips and cheek, radium therapy (abs), 830
of lung, hypertrophic pneumic osteoarthropathy due to bone metastases from (abs), 427
of pharynx, tonsil and extrinsic larynx, treatment by divided doses of external radiation, 717
of skin, radiation therapy, 206
primary, of lung (abs), 267
CANNON, WALTER B., portrait opposite page 575
CARCINOMA, at the cardia, roentgen diagnosis, 43
bronchial, radiosensitiveness (abs), 140
bronchial, serial bronchography in early diagnosis of, 757
of bladder, technique of suprapubic implantation of radon seeds (abs), 275
of breast, radium dosage and technique, 730
of bronchi (abs), 118
of cervix, radiation treatment, 646
of cervix, treatment of, in Detroit, Michigan (abs), 273
of cervix, treatment with small quantities of radium (abs), 275
of colon, roentgen manifestations and differential diagnosis (abs), 423
of larynx, selection of treatment for (abs), 436
of lip (abs), 136
of lip, radium therapy of (abs), 435
of lip, results of roentgen and radium treatment 211
of stomach, examination of mucous folds (abs), 122
of tongue, technique of radium treatment (abs), 435
of uterine cervix, after radiation therapy, clinical observations, 87
of uterus, radiotherapy of, at University Gynecological Clinic of Heidelberg (abs), 141
primary rectal, under radiation treatment, 635
CARTILAGES, costal, calcification of, in normal individuals and those with tuberculosis (abs), 112
CECUM, migratory, 171, 701
CELLS, blood-forming, maturing effect of roentgen rays on (abs), 432
division of, effect of roentgen rays on (abs), 284
radiosensitiveness of (abs), 134
theories in regard to elective action of roentgen rays on (abs), 278
CENTURY OF PROGRESS, roentgen-ray exhibit at, 101
CERVIX UTERI: See Uterus, cervix
CHEEK, cancer, radium therapy (abs), 830
CHEST, roentgen study of, in 200 patients with goiter, 326
shape of, relation of shape of heart to, 464
use of lateral and oblique diameters of (abs), 822
CHILDHOOD, encephalography in psychic and nervous diseases of (abs), 571
resolving exudates in pulmonary tuberculosis of (abs), 112
roentgenographic study of pulmonary disease in (abs), 822
CHILDREN, encephalography in, 437
multiple intracranial tumors in (abs), 821
pulmonary abscess in (abs), 267
roentgen picture of epipharynx of, under normal conditions and by adenoid vegetations (abs), 572
young, relation of measles and tuberculosis in (abs), 113
CHOLANGIOGRAPHY, new technique and results, 167

Cholecystograms, in upright position, observations of (abs), 125
Circulation, evaluation of various methods of investigating, in lower extremities (abs), 433
Cisterns, subarachnoid, significance of abnormally shaped, seen in ecephalogram, 743
Climacteric, roentgen treatment of symptoms (abs), 273
Colitis, roentgen sign of, caused by *Entamoeba histolytica* (abs), 423
Colloidal solutions in examination of mucosa of large intestine (abs), 421
Colon, carcinoma of, roentgen manifestations and differential diagnosis (abs), 423
changes in, in chronic arthritis, compared with other chronic diseases (abs), 423
diverticulitis, clinical and roentgen study (abs), 124
pure invaginations of, from point of view of roentgen examination (abs), 423
relief study of (abs), 121
Corpus callosum, agenesis of, 1
Coutard's method: See Irradiation
Coxitis, tuberculous, roentgenogram in (abs), 826
Curie, Marie Sklodowska, memorial meeting for, 404
notice of death (E), 98
obituary notice (E), 395
portrait opposite page 395
Curie, Pierre, portrait opposite page 395
Cyst, hydatid, of liver, diagnosed by hepatolienography (abs), 707
Cystic disease, congenital, of the lung (abs), 113
Cysticercus, case of human muscle (abs), 133
Cysts of intestinal origin (abs), 124
solitary juvenile bone, late results of operation in (abs), 432
suppurated hydatid, of lung, roentgen diagnosis (abs), 267

Deformities, infantile, of knee and hip (abs), 825
Dental infection and systemic disease (abs), 433
Dentine, roentgen-ray diffraction studies of, 369
Dermatofibrosis lenticularis disseminata, with familial osteopoikilosis (abs), 428
Dermatology, roentgen therapy in, 218
Diabetes, coexistence of benign pulmonary tuberculosis (abs), 115
Diaphragm, left, eventration, roentgen semeiology of (abs), 271
Diaphragms, new types of variable tube-shaped primary (abs), 290
Diet, effect of, on sensitiveness of animal tissues to irradiation (abs), 282
Diffraction studies, roentgen-ray, of enamel and dentine, 369
Digestion, some reflections on process of (Caldwell Lecture, 1934), 575
Diphtheria of vagina, successful treatment of case of (abs), 275

Diverticula, appendicial, two cases of, roentgen study (abs), 422
esophageal (abs), 271
of intestinal origin (abs), 124
Diverticulitis of colon, clinical and roentgen study (abs), 124
Diverticulum, Meckel's, tuberculosis of (abs), 422
Dosage, prolonged, small, development of method of (abs), 135
Duodenum, analysis of 1,000 consecutive examinations of, and stomach, from clinical, roentgen and surgical viewpoints, 179
chronic intermittent stasis of, 161
tuberculosis of (abs), 420
Dura mater, sinuses of, visibility by encephalography (abs), 425
Dystrophy, congenital generalized meta-epiphyseal (abs), 715

Economics, medical, some important phases of, 401
Editorials
Who can practice medicine? 96
The annual meeting, 240
"Shooting through" with roentgen rays? 241
Carlos Heuser, 1878–1934, 242
Health insurance, 389
Marie Sklodowska Curie, 395
The annual meeting, 558
Adolescent kyphosis, 695
Post-traumatic acute bone atrophy, 811
Pasquale Tandoja, 813
Effect, auditory, of roentgen rays in dogs, 675
biological, of gamma rays (abs), 291
biological, of roentgen rays (abs), 836
biological, of roentgen rays, experimental study (abs), 281
biological, of roentgen rays, time factor in (abs), 837
general, of roentgen rays, with special reference to time of its occurrence (abs), 278
maturing, of roentgen rays on blood-forming cells (abs), 432
of continuous exposure of mice to gamma rays of radium, 227
of crowding on head frequency and length of life of *Planaria dorotocephala* exposed to various doses of roentgen rays, 552
of diet on sensitiveness of animal tissues to irradiation (abs), 282
of radium irradiation on tissue cultures (abs), 291
of roentgen and radium rays, comparative examinations of (abs), 142
of roentgen irradiation on action current of nerves (abs), 282
of roentgen irradiation on calcium and potassium metabolism in rabbits (abs), 284
of roentgen irradiation on cholesterin metabolism and compensation for it by giving lipoid by mouth (abs), 142

of roentgen irradiation on mineral metabolism of multiple inoculation sarcoma in white rats (abs), 142
of roentgen rays, elective, on cells, theories in regard to (abs), 278
of roentgen rays on cell division (abs), 284
of roentgen rays on estrual cycle and ovaries of white rat (abs), 284
of roentgen rays on fetus during pregnancy (abs), 284
of roentgen rays on function of secreting organs (abs), 285
of roentgen rays on lymphomatosis of mice, 377
on reticulo-endothelial system of irradiation of tumor animals (abs), 282
EMPHYSEMA, chronic pulmonary, roentgen diagnosis, 11
EMPYEMA or collapsed lung? 198
ENAMEL, roentgen-ray diffraction studies of, 369
ENCEPHALOGRAM, significance of abnormally shaped subarachnoid cisterns seen in, 743
ENCEPHALOGRAPHY, 311
diagnosis of agenesis of corpus callosum by, 1
in children, 437
in psychic and nervous diseases of infancy and childhood (abs), 571
in surgical lesions of brain (abs), 259
observations on, 301
visibility of sinuses of dura mater by (abs), 425
ENCEPHALOMYELOGRAPHY, liquid (abs), 425
ENDOTHELIOMA of bone (abs), 716
so-called pleuropulmonary (abs), 268
Entamoeba histolytica, roentgen sign of colitis caused by (abs), 423
EPIPHARYNX, roentgen picture of, of children under normal conditions and by adenoid vegetations (abs), 572
EPIPHYSES, ununited anomalous, of inferior articular processes of lumbar vertebrae (abs), 713
EPIPHYSIS, proximal, of femur, architecture of spongy tissue of (abs), 827
EPITHELIOMAS of pharynx and larynx, roentgen therapy, 500
ERYTHROCYTES, rapidity of sedimentation of, in malignant tumors before and after roentgen and radium treatment (abs), 277
ESOPHAGUS, aid to roentgen diagnosis of foreign bodies in (abs), 572
diverticula (abs), 271
effect of Valsalva's experiment on (abs), 821
mucosa of, roentgen diagnosis of relief of (abs), 272
upper, roentgenology of (abs), 259
ESTRUAL CYCLE, effect of roentgen rays on, in white rat (abs), 284
EWING'S TUMOR (abs), 716
EXTREMITIES, arteriography of, with thorotrast, technical considerations, 64
lower, evaluation of various methods of investigating the circulation in (abs), 433
EXUDATES, resolving, in pulmonary tuberculosis of childhood (abs), 112

FACE, pathological synostoses of (abs), 110
FACETECTOMY, lumbosacral, for post-fusion persistent sciatica (abs), 713
FEMUR, architecture of spongy tissue of proximal epiphysis of (abs), 827
aseptic necrosis of head of, following traumatic dislocation of hip joint (abs), 826
FETUS, case of injury of, by roentgen rays (abs), 283
effect on, of extragenital radium irradiation during pregnancy (abs), 283
FIBRIN BODIES in pleural cavity, 613
FIBULAE, breaking strength of healing fractured, of rats (abs), 290
FISTULA between esophagus and lung and diverticulum with atypical course in case of megaesophagus (abs), 261
FOREIGN BODIES, aid to roentgen diagnosis of, not visible on ordinary roentgenography, in hypopharynx and esophagus (abs), 572
localization of, with roentgenoscope, 412
FRACTURES, calcium stream as concerned with healing of, 457
isolated, of articular processes of lumbar vertebrae (abs), 712
isolated, of os magnum and trapezium (abs), 711
multiple spontaneous idiopathic symmetrical, 622
of vertebrae, prognosis, 617
of vertebral column, treatment (abs), 129

GALLBLADDER, effect of chronic duodenal obstruction on evacuation of (abs), 272
human, function of, studied in connection with blood transfusions and after stomach operations (abs), 416
roentgenologic documents on pathogenesis of hepatic colics (abs), 706
study of reflex evacuation of (abs), 707
GALLSTONES, new roentgen sign (abs), 125
GAMMA RAYS, biological effects of (abs), 291
GANGLIA, sympathetic, irradiation of dorsal chain of, and its effect on the stomach (abs), 278
GASTRIC DISORDERS, study of, following phrenicectomy (abs), 416
GASTROINTESTINAL TRACT, cysts and diverticula of (abs), 124
new suspension medium for barium sulphate in examination of (abs), 836
GAUCHER'S DISEASE (abs), 132
GOITER, exophthalmic, carbohydrate metabolism in patients with, and changes in it under roentgen therapy (abs), 139
exophthalmic, does irradiation in, cause death? (abs), 139
exophthalmic, roentgen therapy (abs), 138
malignant, results of surgical treatment (abs), 139

roentgen study of chest in 200 patients with, 326
toxic, changes observed in heart shadows in, before and after treatment (abs), 270
Grier, George W., portrait opposite page 437
Gumma, giant, of lung, regressive evolution and healing of, followed under roentgenoscope (abs), 266

Hand, primary new growths involving, 516
Health insurance (E), 389
Heart, changes observed in shadow of, in toxic goiter before and after treatment (abs), 270
compensating pantograph for obtaining actual size tracings of, with the roentgenoscope, 411
congenital diseases of (abs), 120
constitutional types of (abs), 121
effect of thoracoplasty on (abs), 270
functional-dynamic method of cardioroentgenology (abs), 287
relation of shape of, to shape of chest, 464
roentgen determination of size of, in 300 males in their twenties (abs), 269
roentgen kymographic curves of revolution of (abs), 833
Hemangioma of vertebral column (abs), 714
Hepatosplenography (abs), 126
hydatid cyst of liver diagnosed by (abs), 707
recent observations on, with thorotrast (abs), 126
Hernia, anterior superior mediastinal, in therapeutic pneumothorax (abs), 119
of apex of lung, discovered by roentgen examination (abs), 822
Heublein's method of continuous irradiation of entire body for generalized neoplasms, 654
Heuser, Carlos, obituary notice (E), 242
portrait, 242
Hip, infantile deformities of (abs), 825
joint, case of arthrokatadysis of (abs), 825
joint, traumatic dislocation of, aseptic necrosis of head of femur following (abs), 826
Humerus varus and snapping scapula (abs), 430
Hyperkeratosis from roentgen rays, treatment, 816
Hypernephroma, bone metastases from (abs), 128
Hyperparathyroidism, roentgen therapy of, 72
with parathyroid tumor (abs), 427
Hyperthyroidism, absence of osteoporosis demonstrated chemically in (abs), 130
roentgen therapy of (abs), 138
Hypertrophy, total unilateral (abs), 131
Hypopharynx, aid to roentgen diagnosis of foreign bodies in (abs), 572
Hypophysis, experimental study of irradiation of (abs), 277
roentgen therapy of diseases of (abs), 143
tumors of, technique of radium therapy (abs), 137

Ileus, duodenal (abs), 272
Infancy, encephalography in psychic and nervous diseases of (abs), 571
Infants, new-born, massive collapse of lung in (abs), 822
young, tetany in (abs), 127
Insurance, health (E), 389
International Congress of Electrobiology, first, 101
International Congress of Radiology, fourth, 566
Intervertebral disc, case of backward dislocation of (abs), 431
enlargement of, associated with decalcification of vertebral body (abs), 714
Intestine, lacunar images of ceco-ascendens (abs), 421
large, clinical results of roentgen exploration of internal relief of (abs), 709
large, colloidal solutions in examination of mucosa of (abs), 421
large, mucous membrane design of, under normal and pathological conditions (abs), 421
large, roentgen picture of syphilitic lesions of (abs), 125
large, techniques of examination of mucosa of (abs), 708
normal small, roentgen study of morphology and physiology of (abs), 420
roentgen signs of cystic pneumatosis of (abs), 420
tuberculosis, calcification in, 782
Invagination of stomach, two cases (abs), 122
pure, of colon, from point of view of roentgen examination (abs), 423
Iodized oil, use of, in bronchography, 763
Irradiation by Coutard's method, roentgen ulcer after (abs), 135
protracted fractional, preliminary experience with (abs), 280
protracted fractional roentgen and radium, Tyndallmetric serum examinations in (abs) 279
results in protracted fractional (abs), 289

Kidney, demonstration of lymphatic vessels of, 358
new method for determination of function of, 818
tumors, present status of diagnosis, 769
Klippel-Feil syndrome (abs), 712
Knee, infantile deformities of (abs), 825
joint, subchondral granulation tissue in tuberculosis of (abs), 824
pneumography of (abs), 431
post-traumatic calcification of collateral tibial ligament of (Pellegrini-Stieda's disease), 189
roentgen findings in acute gonococcal synovitis of, treated by pneumarthrosis (abs), 824

KYMOGRAPHY, new method for (abs), 832
résumé of new roentgen technique for (abs), 833
roentgen curves in cardiac revolution (abs), 833
roentgen, in phthisiologic practice (abs), 834
KYPHOSIS, adolescent (E), 695

LARYNX, carcinoma of, selection of treatment for (abs), 436
extrinsic, cancer, treatment by divided doses of external radiation, 717
intractable papilloma of, in adults, treatment (abs), 830
malignant neoplasms of, roentgen therapy of (abs), 436
papillomata of (abs), 829
papillomata of, efficacity of roentgen rays in treatment of (abs), 435
researches on normal and pathologic roentgenography of (abs), 573
roentgen study of tuberculosis of, 589
roentgen therapy of epitheliomas of, 500
LESIONS, benign, of skin, radium dosage and technique, 735
LEUCEMIA, acute, following lymphosarcoma (abs), 132
acute, mediastinal tumor in (abs), 118
LINITIS PLASTICA (abs), 123
LIP, cancer, radium therapy (abs), 830
carcinoma of (abs), 136
carcinoma of, radium therapy of (abs), 435
carcinoma of, results of roentgen and radium treatment, 211
"LITTLE OLD LADY IN BLACK," 102
LIVER, and spleen, simultaneous irradiation, in treatment of pyogenic processes (abs), 140
effect of roentgen irradiation in function of (abs), 141
hydatid cyst of, diagnosed by hepatolienography (abs), 707
LISFRANC'S LINE, roentgen picture of traumatic lesions of (abs), 132
LUNG, collapsed, or empyema? 198
hernia of apex of, discovered by roentgen examination (abs), 822
LUNGS, abscess of, in children (abs), 267
accessory lobes of pulmonary base (abs), 705
azygos vein, roentgen picture of, in normal position (abs), 261
case of extensive intrapulmonary air-containing hollow spaces (abs), 111
comparison of roentgen-ray densities with pathology of, 317
congenital cystic disease of (abs), 113
giant excavation and emphysematous bulla mistaken for pneumothorax, 322
hila of, roentgen study (abs), 268
human, evolution of tuberculosis in (abs), 263
limits of visibility of bronchopulmonary foci (abs), 117
lobectomy and pneumectomy in dogs (abs), 834
localized experimental tuberculosis of (abs), 263
lower accessory lobe of (abs), 573
massive collapse, complicating pulmonary tuberculosis (abs), 116
massive collapse, importance in pulmonary tuberculosis (abs), 116
massive collapse, in new-born infants (abs), 822
massive collapse, internal drainage a factor in production of postoperative (abs), 266
massive collapse, postoperative (abs), 118
massive collapse, roentgen appearance of, and simulating conditions (abs), 115
primary cancer (abs), 267
regressive evolution and healing of giant gumma of, followed under roentgenoscope (abs), 266
roentgen examination of apex (abs), 117
roentgen study of cardiac lobe and of supplementary scissura which delimits it (abs), 704
roentgenographic study of disease of, in childhood (abs), 822
scissural surfaces of, and their mediastinal diaphragmatic relation (abs), 704
so-called pleuropulmonary endothelioma (abs), 268
suffocating form of cancerous lymphangitis of (abs), 705
suppurated hydatid cysts of, roentgen diagnosis (abs), 267
vena azygos lobe in roentgenogram (abs), 574
vessels of, their visibility (angiopneumography) (abs), 261; (abs), 828
LUPUS, roentgen treatment (abs), 135
LUXATIONS of shoulder joint, roentgenology of (abs), 711
LYMPH VESSELS, roentgen demonstration in cadaver and living subject by means of umbrathor and thorotrast (abs), 133
LYMPHANGITIS, cancerous, of lungs, sufficating form of (abs), 705
LYMPHATIC systems, roentgen investigation of, of human and animal subjects (abs), 282
vessels of pleura, demonstration of, by means of intrapleural injections of thorotrast (abs) 835
vessels, renal, demonstration of, 358
LYMPHOMATOSIS of mice, effect of roentgen rays on, 377
LYMPHOSARCOMA, acute leucemia following (abs), 132

MALIGNANT DISEASES of thyroid gland, 508
MARCH FOOT (abs), 827
MEASLES, relation of, to tuberculosis in young children (abs), 113
MEASUREMENTS, units of, of roentgen rays and gamma radiation (abs), 279; (abs), 280
MEDIASTINITIS, 23

Mediastinum, anterior superior hernias of, in therapeutic pneumothorax (abs), 119
tumor of, in acute leucemia (abs), 118
Medicine, who can practice? (E), 96
Melanoma, malignant, of skin and vulva, treatment of, at Radiumhemmet, Stockholm (abs), 831
Melville, Stanley, memorial to, 701
Mesenterium commune, roentgen study (abs), 420
Metabolism, calcium and potassium, effect of roentgen irradiation on, in rabbits (abs), 284
carbohydrate, in Basedow's disease, and changes in it under roentgen therapy (abs), 139
cholesterin, effect of roentgen irradiation on, and compensation for it by giving lipoid by mouth (abs), 142
mineral, effect of roentgen irradiation on, of multiple inoculation sarcomas of white rats (abs), 142
Metastases, bone, from cancer of lung, hypertrophic pneumic osteoarthropathy due to (abs), 427
Metropathies, hemorrhagic, roentgen treatment over single abdominal field (abs), 274
Minnesota Radiological Society, 567
Mucosa, esophageal, roentgen diagnosis of relief of (abs), 272
Muscle, case of cysticercus in human (abs), 133
Myelosis, aleukemic, with osteosclerosis (abs), 824
Myomas, roentgen treatment over single abdominal field (abs), 274

Neck, roentgen study of tuberculosis of, 589
Neoplasms, gastric, metastatic infection of bone and joints as initial clinical manifestation of (abs), 823
generalized, Heublein's method of continuous irradiation of entire body for, 654
malignant, of pharynx and larynx, roentgen therapy of (abs), 436
primary, involving the hand, 516
Nerve, acoustic, tumor of (abs), 110
Nerves, effect of roentgen irradiation on action current of (abs), 282
Newborn, spontaneous pneumothorax in (abs), 112
Niemann-Pick's disease and other forms of so-called xanthomatosis (abs), 710

Oleothorax, roentgen appearance (abs), 704
Optic foramen, new projection for roentgenology of (abs), 835
Organs, secreting, effect of roentgen rays on function of (abs), 285
Os magnum, fractures of (abs), 711
subtibiale, an inconstant bone over tip of medial malleolus (abs), 827
Osgood-Schlatter's disease (abs), 131
Ossification of stylohyoid apparatus (abs), 260
Osteitis fibrosa cystica at an unusual age (abs), 823
Osteoarthropathy, hypertrophic pneumic, due to bone metastases from cancer of lung (abs), 427
Osteochondrodystrophy (abs), 715
Osteochondrolysis, circumscribed (abs), 131
Osteomyelitis, chronic, of spine (abs), 128
chronic scerlosing (Garré) (abs), 716
of spine, benign form of (abs), 431
traumatic, of cranial vault (abs), 259
Osteomyelography, experimental intravenous (abs), 291
Osteopoikilosis, familial, and dermatofibrosis lenticularis disseminata (abs), 428
report of unusual case, 52
Osteoporosis, absence of, demonstrated clinically in hyperthyroidism (abs), 130
Osteosclerosis, aleukemic, myelosis with (abs), 824
anemia associated with (abs), 130
Ottonello image (abs), 268
Ovaries, effect of roentgen rays on, in white rat (abs), 284
Ovary, papillary tumors of, value of irradiation (abs), 273

Pacchionian depressions, of the frontal bone, roentgen picture (abs), 571
Palate, soft, radium therapy of tumors of (abs), 137
Pancreas, duodenal roentgen signs of lesions of (abs), 419
roentgen study of disease of (abs), 419
Pantograph, compensating, for obtaining actual size tracings of heart with the roentgenoscope, 411
Paper, negative, application of, to roentgenographic technique (abs), 286
roentgen, application of, to roentgenologic exposures (abs), 285
Papilloma, intractable laryngeal, in adults, treatment (abs), 830
multiple, of larynx (abs), 829
of larynx, efficacity of roentgen rays in treatment (abs), 435
Parathyroid, operations in region of, and deforming rheumatism (abs), 429
tumor of, hyperparathyroidism with (abs), 427
Pellegrini-Stieda's disease, 189
Pelvis, tumors of (abs), 432
Peptic ulcer, double or multiple (abs), 123
genesis and significance of roentgen picture in (abs), 707
relation of pain of, to gastric motility and acidity (abs), 417
ring picture in (abs), 122
roentgen diagnosis of postoperative (abs), 417
roentgen evidence of healing of, 487
roentgen images of different phases of development (abs), 707
various aspects of ulcerous bulb (abs), 418
Pericarditis (abs), 269; (abs), 270

chronic adherent (abs), 269
with effusion (abs), 270
PERICARDIUM, calcification of (abs), 269
PERTHES' DISEASE, case of atypical, 353
possible early sign of (abs), 130
PERTUSSIS, roentgen therapy of (abs), 830
PHARYNX, cancer, treatment by divided doses of external radiation, 717
malignant neoplasms of, roentgen therapy of (abs), 436
reticulo-endotheliomas of, radium therapy (abs), 137
roentgen therapy of epitheliomas of, 500
roentgenogram of motor changes in (abs), 572
roentgenology of (abs), 259
PHOTELOMETER, Sheard-Sanford, use of, in determination of small quantities of roentgen rays, 408
PHOTOGRAPHIC SPECTRA, simple method of photometering, 384
PHOTOMETRY, photographic, of roentgen rays, 789
PHRENICECTOMY, study of gastric disorders following (abs), 416
PITTSBURGH, past and present, 247
Planaria dorotocephala, effects of crowding on head frequency and length of life of, exposed to various doses of roentgen rays, 552
PLEURA, demonstration of lymphatics of, by means of intrapleural injections of thorotrast (abs), 835
parietal, normal roentgenology (abs), 111
PLEURAL CAVITY, fibrin bodies in, 613
PLEURISY, interlobar (abs), 263
PNEUMARTHROSIS, roentgen findings in acute gonococcal synovitis of knee treated by (abs), 824
PNEUMATOSIS, cystic, of intestine, roentgen signs (abs), 420
PNEUMOCONIOSIS in workers in barytes (abs), 264
PNEUMOGRAPHY of knee (abs), 431
PNEUMOPERICARDIUM, spontaneous, case of (abs), 269
PNEUMOTHORAX, giant excavation and emphysematous bulla mistaken for, 322
incomplete, superior value of expiratory roentgenogram in diagnosis of, 330
spontaneous, in the newborn (abs), 112
spontaneous, with acute abdominal symptoms (abs), 115
spontaneous, with aortic aneurysm and pulmonary fibrosis (abs), 120
therapeutic, anterior superior mediastinal hernias in (abs), 119
PSORIASIS, irradiation in treatment of, 82
PULMONARY VEIN, varix, 608
PYOGENIC PROCESSES, simultaneous irradiation of liver and spleen in treatment of (abs), 140

r output of roentgenoscopic equipment, importance of measuring, 702

RADIATION, physical aspects of various qualities of, 235; (E), 241; 561; 562
RADIOLOGICAL SOCIETY OF NORTH AMERICA, announcement of meeting, 568
RADIOLOGIST, position in hospital scheme (abs), 832
RADIOSENSITIVENESS of cells and tissue (abs), 134
RADIUM, effect of continuous exposure of mice to gamma rays of, 227
indiscriminate use and rental of, 251
pack intensities, analysis of factors entering into (abs), 277
therapy, training for, 222
water, poisoning from drinking (abs), 292
RECTUM, primary carcinoma, under radiation treatment, 635
RESOLUTION for endorsement by American Roentgen Ray Society, 104
RETICULO-ENDOTHELIAL SYSTEM, effect on, of irradiation of tumor animals (abs), 282
treatment of certain affections of, by teleroentgen therapy (abs), 433
RETICULO-ENDOTHELIOMAS of tonsil and pharynx, radium therapy (abs), 137
RETINA, roentgen treatment of venous thrombosis of (abs), 134
RHEUMATISM, deforming, operations in region of parathyroids for (abs), 429
new form of chronic fibrous (abs), 428
RIB, supernumerary, arising from second lumbar vertebra, 196
RICKETS, renal (abs), 428
ROENTGEN paper, application of, to roentgenologic exposures (abs), 285
ray exhibit at Century of Progress, 101
ray readings, method of recording (abs), 290
rays, auditory effects of, in dogs, 675
rays distribution of, within human body, 534
rays high voltage, measurements of (abs), 837
rays, hyperkeratosis from, treatment, 816
rays, photographic photometry of, 789
rays, sensitivity of organic desmotropic compounds to (abs), 286; (abs), 287
rays, "shooting through" with? (E) 241
rays, use of Sheard-Sanford photelometer in determination of small quantities of, 408
sickness, and roentgen death, experimental studies of (abs), 285
therapy, deep, thickness of aluminum to be used in addition to copper filters, 92
therapy, surface, present status (abs), 289
tube, new method of cooling anode of (abs), 288
tubes, disturbances affecting radiation output of (abs), 286
tubes, operation of thick-walled, on rectified potentials, 524
tubes, relative output of, in Greinacher and Witka circuits in an apparatus with an alternative connection (abs), 287
ROENTGENOGRAM, expiratory, superior value of, in diagnosis of incomplete pneumothorax, 330

Roentgenograms, distant, apparatus for focussing typical and atypical (abs), 835
legal aspect of identification and interpretation of, 680
superimposed striations in (abs), 287
Roentgenography, pulmonary, of small experimental animals (abs), 290
Roentgenoscopic equipment, importance of measuring r output of, 702
Roentgenoscopy, dangers of, 699, 816
dangers of, and methods of protection against them, 360, 805
in tuberculosis case-finding (abs), 115

Sarcoma, multiple inoculation, in white rats, effect of roentgen irradiation on mineral metabolism of (abs), 142
Scapula, snapping, and humerus varus (abs), 430
Schinz, Hans R., portrait on page 94
Sciatica, lumbosacral and peripheral roentgen treatment (abs), 831
post-fusion persistent, lumbosacral facetectomy for (abs), 713
Sensitivity of organic desmotropic compounds to roentgen rays (abs), 286; (abs), 287
Shoulder joint, roentgenology of luxations of (abs), 711
Silicosis, pulmonary, and amyloidosis (abs), 706
Sinus, maxillary, form, size and position of, at various ages, studied by means of roentgenograms of skull, 154
Sinuses of dura mater, visibility of, by encephalography (abs), 425
paranasal, tumors of, technique of radium therapy (abs), 137
Sinusitis, odontogenous, of antrum of Highmore (abs), 821
Skin, benign lesions, radium dosage and technique, 735
cancer of, radiation therapy, 206
malignant melanomas of, treatment at Radiumhemmet, Stockholm (abs), 831
Skull, form, size and position of maxillary sinus at various ages studied by means of roentgenograms of, 154
pathological synostoses of (abs), 110
traumatic osteomyelitis of vault of (abs) 259
Spectrum, roentgen and radium, comparison of, 808
Spine, cervical, absence of (abs), 712
chronic osteomyelitis of (abs), 128
fractures of, treatment (abs), 129
hemangioma of (abs), 714
osteomyelitis of, benign form of (abs), 431
Spleen and liver, simultaneous irradiation of, in treatment of pyogenic processes (abs), 140
Spondylitis, primary (abs), 431
Stasis, duodenal, chronic intermittent, 161
Stereoroentgenoscopy and stereoroentgenography, new apparatus for (abs), 835
Sterilization by a single one-field irradiation (abs), 282
Stierlin's symptom in appendicitis (abs), 124
Stomach, analysis of 1,000 consecutive examinations of, and duodenum, from clinical, roentgen and surgical viewpoints, 179
carcinoma, examination of mucous folds (abs), 122
cardia, carcinoma, roentgen diagnosis, 43
effect on, of irradiation of dorsal chain of sympathetic ganglia (abs), 278
insufflation of, in clinical roentgenology (abs), 417
invagination of, two cases (abs), 122
neoplasms, metastatic infection of bone and joints as initial clinical manifestation of (abs), 823
passage of food through (abs), 121
relief study of (abs), 121
studies of muscularis mocosa of (abs), 416
syphilis of (abs), 123; (abs), 708
Stylohyoid apparatus, case of ossification of (abs), 260
Sudeck's atrophy (E), 811
Symphysis pubis, changes in, and sacroiliac articulations, as result of pregnancy and childbirth (abs), 432
in the female, 333
Synostoses, pathological, of the skull and face (abs), 110
Synovitis, acute gonococcal, of knee treated by pneumarthrosis, roentgen findings in (abs), 824
Syphilis of bursae (abs), 427
of large intestine, roentgen picture of lesions of (abs), 125
of stomach (abs), 123; (abs), 708
of various bones, probably one of late congenital (abs), 426
Syringomyelia, roentgen treatment (abs), 276
Syringomyelic cavity, new decompressive and evacuating method of, by puncture made at its lower pole (abs), 426

Tandoja, Pasquale, notice of death of (E), 696
obituary notice (E), 813
Tarsus, roentgen examination in traumatic lesions of (abs), 827
Technique, a procedure to produce by one exposure two negatives of different quality (abs), 287
roentgen, research and development in field of (abs), 290
Teleradium treatment, new apparatus for, at Radiumhemmet (abs), 292
Teleroentgen therapy, technique of (abs), 433
Tetany in young infants (abs), 127
Thoracoplasty, effects of, on heart (abs), 270
Thorotrast, arteriography of extremities with, technical considerations, 64

demonstration of lymphatics of pleura by means of intrapleural injections of (abs), 835
recent observations on hepatosplenography with (abs), 126
used for roentgen demonstration of blood and lymph vessels in cadaver and living subject (abs), 133
THROMBOSIS, venous, of retina, roentgen treatment (abs), 134
THYROID GLAND, malignant diseases of, 508
TISSUE, cultures of, effects of radium irradiation on (abs), 291
radiosensitiveness of (abs), 134
TISSUES, animal, effect of diet on sensitiveness of, to irradiation (abs), 282
TONGUE, carcinoma of, technique of radium treatment (abs), 435
TONSIL, cancer, treatment by divided doses of external radiation, 717
reticulo-endotheliomas of, radium therapy (abs) 137
TRAPEZIUM, fracture of (abs), 711
TUBERCULOSIS, calcification of costal cartilages in individuals with (abs), 112
calcified pulmonary miliary (abs), 264
correlation of blood counts in 150 clinical cases of, and underlying pathological changes as shown by serial x-ray films (abs), 264
duodenal (abs), 420
evolution of, in human lung (abs), 263
exogenous infection of adults (abs), 265
fluoroscopy in case finding in (abs), 115
intestinal, calcification in 782
localized experimental, of lung (abs), 263
of knee joint, subchondral granulation tissue in (abs), 824
of larynx and neck, roentgen study, 589
of Meckel's diverticulum (abs), 422
progress in diagnosis of, with special reference to x-ray (abs), 117
pulmonary, application of angiopneumography in (abs), 262
pulmonary, benign, with diabetes (abs), 115
pulmonary, importance of atelectasis in (abs), 116
pulmonary, massive atelectasis complicating (abs), 116
pulmonary, of childhood, resolving exudates in (abs), 112
pulmonary, pathological anatomy of, in American negro and in white race (abs), 265
relation of, to measles, in young children (abs), 113
roentgen kymography in (abs), 834
studies on pathogenesis of primary infection, regressive lesions (abs), 114
studies on pathogenesis of primary infection, tendencies in adult primary tuberculous infection (abs), 114
types of lesions found in chests of students of nursing and medicine (abs), 114
TUMOR, giant cell, of second cervical vertebra (abs), 711
mediastinal, in acute leucemia (abs), 118
of acoustic nerve (abs), 110
of brain with destruction of cranium cured for five years by radiotherapy (abs), 435
TUMORS, benign and malignant, systematic determination of an optimum rhythm for radiotherapy of (abs), 143
classification of, from standpoint of radiosensitiveness, 493
ideas of reversibility and non-reversibility in radiotherapy of (abs), 292
malignant, rapidity of sedimentation of erythrocytes in, before and after roentgen and radium treatment (abs), 277
multiple intracranial, in children (abs), 821
of bone, irradiation in treatment of (abs), 274
of hypophysis and paranasal sinuses, technique of radium therapy (abs), 137
of pelvic bones (abs), 432
of soft palate, radium therapy (abs), 137
of temporal lobe, ventriculography in diagnosis of, 145
papillary ovarian, value of irradiation (abs), 273
renal, present status of diagnosis, 769
TYNDALLMETRIC serum examinations in protracted fractional roentgen and radium irradiation (abs), 279

ULCER, roentgen, after irradiation by Coutard's method (abs), 135
UMBRATHOR, used for roentgen demonstration of blood and lymph vessels in cadaver and living subject (abs), 133
URETHROGRAPHY, cases of (abs), 424
URINARY APPARATUS, roentgen picture of, by elimination urography (abs), 127
UROGRAPHY, elimination, roentgen picture of urinary apparatus by (abs), 127
excretory, practical application of (abs), 425
intravenous, special device for ureteral compression, 254
UTERUS, carcinoma, radiotherapy of, at University Gynecological Clinic of Heidelberg (abs), 141
cervix, adenocarcinoma, experience with (abs), 831
cervix, adenomas, radiotherapy of (abs), 144
cervix, carcinoma, after radiation therapy, clinical observations, 87
cervix, carcinoma, radiation treatment, 646
cervix, carcinoma, treatment of, in Detroit, Michigan (abs), 273
cervix, carcinoma, treatment with small quantities of radium (abs), 275

VAGINA, diphtheria of, successful treatment of stubborn case of (abs), 275
VALSALVA'S EXPERIMENT, effect of, on esophagus (abs), 821

Varix of pulmonary vein, 608
Ventriculograms, interpretation of, 145
Vertebra, second cervical, giant cell tumor of (abs), 711
second lumbar, supernumerary rib arising from, 196
Vertebrae, lumbar, isolated fractures of articular processes of (abs), 712
lumbar, spinous processes of, and soft tissues between them and on pathological changes in that region (abs), 129
lumbar, ununited anomalous epiphyses of inferior articular processes of (abs), 713
prognosis of fractures of, 617
Vertebral body, enlargement of intervertebral disc associated with decalcification of (abs), 714
Voltage, higher x-ray, comment on (abs), 434
Vulva, malignant melanomas of, treatment at Radiumhemmet, Stockholm (abs), 831

Xanthoma multiplex, juvenile (abs), 133
Xanthomatosis, forms of (abs), 710
generalized (abs), 710
roentgen treatment (abs), 829

AUTHOR INDEX TO VOLUME XXXII

Abel Alves, 425
Adams, W. E., 834
Adelstein, L. J., 259
Adler, Karl, 284
Adler, Margarethe, 284
Agati, Dino, 572
Åkerlund, Åke, 125, 290
Aleu Saldanha, 261
Allende, Guillermo, 428
Almeida Lima, 262
Alpers, Bernard J., 134
Anton, Günther, 279
Anzilotti, Alberto, 122
Arneson, A. Norman, 646
Arnett, John H., 433
Arrigoni, Arturo, 126

Baastrup, Chr. I., 129
Babaiantz, L., 420
Baldenweck, L., 573
Bale, William F., 369
Balestra, Giovanni, 117, 131
Banner, E. H. W., 837
Banu, N., 706
Banyai, Andrew L., 268
Barbacci, Gino, 133
Barclay, A. E., 700
Barnes, John M., 333
Barringer, B. S., 275
Bass, Murray H., 822
Béclère, Henri, 417
Behan, Richard J., 434
Beilin, David S., 179
Bell, Joseph C., 565
Benassi, Enrico, 123
Bentzen, Toralf E., 822
Bernard, Léon, 834
Bernstein, Maurice A., 836
Beutel, A., 141
Biro, Stefan, 283
Bistolfi, Stefano, 131
Blake, T. H., 827
Blass, G., 273
Bloch, Robert G., 263
Böhm, Max, 825
Bollini, Vincenzo, 269
Bonafe, 416
Bonanno, A. M., 278
Bordet, Émile, 833
Bouwers, A., 287, 290
Bowing, Harry H., 635, 738
Bozzetti, Giuseppe, 432
Braasch, William F., 425
Bragg, William, 405
Brav, Ernest A., 824
Bredeck, J. F., 824
Brown Percy, 575
Bruno, Giovanni, 827
Brunschwig, Alexander, 132
Buckstein, Jacob, 171, 487, 701
Buisson, Mario, 417
Buisson, Paolo, 125
Burman, M. S., 430
Buschke, Franz, 569

Caldwell, W. E., 563
Calò, A., 282
Cameron, William H., 222
Camplani, Mario, 426
Cannon, Walter B., 575
Capua, Antonio, 704, 835
Carey, J. B., 706
Carlsund, Herbert, 572
Carson, P. C., 821
Casati, Annibale, 821
Case, James T., 242
Chamberlain, W. E., 565
Chaoul, H., 287
Chapman, Earle M., 130
Chizzola, Giuliano, 131, 571
Christiansen, Harald, 121
Christie, Arthur C., 98, 392
Cignolini, Pietro, 121
Cilley, Earl I. L., 360, 408, 805
Coakley, Cornelius G., 500
Codet, 833
Coe, Fred O., 564
Cohen, Lee, 830
Cohen, Philip, 127
Cola, G., 276
Cole, Lewis Gregory, 569
Cole, William Gregory, 569
Compton, Arthur H., 241
Comroe, Bernard I., 427
Conte, E., 110, 829
Cooke, Jean V., 118
Copeland, Murray M., 534
Coryllos, Pol. N., 116
Costa, A., 829
Costedoat, A., 705
Courville, C. B., 259
Craver, Lloyd F., 654
Cristofanetti, Paolo, 124
Crosby, Edward H., 711
Culler, Elmer, 675
Cutler, Max, 275

Daan, Albert, 574
Dall'Acqua, Virgilio, 263
Davidoff, Leo M., 1, 743
Davies, Hugh, 106
D'Emidio, Angelo A., 137
D'Esopo, Anthony, 563
Delaney, P. A., 420
Delherm, 833
Delherm, L., 831, 833
Desjardins, Arthur U., 134, 493
Dietel, F. G., 141
Dragstedt, L. R., 420
Drane, Robert, 565
Drips, Della G., 284
Dubrow, James L., 115
Dumitrescu, Jean, 424
Dunham, Kennon, 317
Duval, Pierre, 417
Dyke, Cornelius G., 1, 743

Egas-Moniz, 261, 262, 425, 828
Eller, Joseph J., 218
Elliott, Arthur R., 428
Englestad, Rolf B., 260, 406
Ennis, LeRoy M., 433
Epifanio, G., 276
Everett, Franklin R., 265

Fariñas, Pedro L., 757
Farrell, J. T., Jr., 565
Fatou, E., 271
Faulkner, E. C., 118, 266
Faulkner, William B., Jr., 118, 266,
Feci, Lorenzo, 264
Feldman, Maurice, 161
Feldweg, P., 144
Fernando de Almeida, 425
Ferretti, Luigi, 125
Fetter, Dorothy, 417
Field, Henry, Jr., 565
Fiorenzi, Oliviero, 117
Fischgold, 833
Fischgold, H., 833
Flahiff, E. W., 115
Fletcher, Eleanor, 436
Flinn, John W., 264
Flinn Robert S., 264
Flinn, Zebud M., 264
Flint, H. T., 279
Ford, Frances A., 284
Forsberg, Ragnar, 829
Forssberg, Arne, 837
Forster, Paul, 134
Foster, John H., 829
Fränkel, S. R., 571
Francisco, Clarence B., 432
Franke, H., 285
Franklin, K. J., 405
Fray, Walter W., 11
Freund, E., 353
Fricke, Robert E., 635
Fried, Carl, 282
Friedenwald, Julius, 161
Friedman, J., 565
Frimann-Dahl, J., 829, 835
Fuhs, H., 284
Furth, J., 227, 377

Gage, H. C., 130
Gallavresi, Luigi, 420
Garcia-Calderon, J., 705, 708
Gardner, W. James, 259
Garr, Chas. C., 715
Gasul, Benjamin M., 112
Gauillard, R., 573
Gavazzeni, Antonio, 122
Gerin, Cesare, 112
Gettler, Alexander O., 292
Ghimus, 269
Ghormley, R. K., 564
Gilbert, R., 709
Ginsberg, Sidney 824
Girden, Edward, 675
Glanzer, Joseph, 131
Goldhaft, Arthur D., 430
Goldhammer, H., 273
Goldstein, D. W., 427
Gorjelik, R., 276
Gosset, 830
Grado, Giuseppe, 131
Grandgerard, Roger, 704
Grant, Francis C., 311
Granzow, Joachim, 283
Greenberg, Lewis, 712
Greenberg, Sidney, 290, 330
Greene, Earle I., 711
Grier, G. W., 206
Grill, John, 268
Grimmett, L. G., 279
Groth, Karl-Erik, 572
Gutierrez, Robert, 105
Gutman, René A., 106, 418, 419

Haahti, H. G., 111
Haft, Henry H., 423
Hall, E. Walter, 398, 617
Hammer, G., 135
Hansen, Olga S., 270
Harding, D. B., 715
Hartoch, Werner, 285
Harvey, S. C., 290
Haslhofer, 432
Hawley, S. J., 326
Hayden, Edward M., 431
Hayer, E., 288
Haymaker, Webb, 322
Heacock, C. H., 782
Headland, Courtenay I., 569
Healy, William P., 646
Heim de Balsac, R., 271
Hellmer, Hans, 431
Hellwig, C. A., 821
Hench, P. S., 564
Hennell, Herman, 115
Hermodsson, I., 406, 711
Herrman, William G., 565
Herrnheiser, G., 140, 280
Herzfeld, E., 279
Hetherington, H. W., 115
Hilt, Lawrence M., 702
Hitzrot, Lewis H., 427
Hodge, Harold C., 369
Hodges Fred J., 563
den Hoed, D., 286
Hoede, Karl, 135
Holbrook, W. Paul, 431
Holfelder, H., 143
Holthusen, H., 142
Howard, Campbell, 301
Howard, C. P., 123
Hurzthal, L. M., 270

Illick, H. Earl, 43, 254, 566
Isaacs, Raphael, 432
Isola, Armando, 110
Israelski, M., 272, 285

Jahiel, R., 419
Jalet, J., 268
Jarre, Hans A., 358
Jimeno-Vidal, F., 129
Johner, W., 292
Johnson, Vincent C., 563
Jovin, I., 421
Junghagen, Sven, 431
Juris, Kalman, 286

Kabakjian, D. H., 227
Kadrnka, S., 291, 420, 422, 709
Kaplan, Ira I., 740
Kapo, Peter J., 293
Karan, A. A., 322
Kasabach, Haig H., 272
Kato, Katsuji, 132
Katz, Traian, 424
Kelly, Edmund, 435
v. Kemeri, D., 140
Kenney Mary J., 552
Kenyon, H. R., 254
Kerley, P., 120
Ketterer, Clarence H., 120
Kiesel, Magda, 142
Kirklin, B. R., 252, 360, 564, 805
Kluge, Lieselotte, 142
Knutsson, Folke, 111, 706
Kögel, G., 286, 287
Kohn, Jerome L., 113
Koiransky, Henry, 113
Konikov, William M., 818
Kornblum, Karl, 23, 311
Korol, Ephraim, 198
Koschewnikow, A. M., 571
Kovács, Andreas, 416
Kramer, David W., 433
Kudisch, B. M., 287

Landauer, Robert S., 235, 563
Lang, F. J., 432
Lapidus, Paul W., 827
Laurell, Hugo, 423
Leddy, Eugene T., 360, 408, 805
Ledoux-Lebard, R., 705, 708
Lenarduzzi, Guerrino, 822
Lenz, Maurice, 436, 500, 738
Levene, George, 411, 818
Lindsay, Merrill K., 711
Livingstone, H. M., 834
Liwschitz, S., 276
Lönnerblad, L., 122
Löw-Beer, A., 281
Lopo de Carvalho, 261, 262, 828
de Lorimier, Alfred A., 457
Lüdin, M., 138, 268
Lumsden, R. W., 290
Lupo, Massimo, 423

McBride, Angus, 267
MacComb, William S., 654
McFetridge, Elizabeth M., 64
McGraw, Arthur B., 133
McKeown, R. M., 290
MacLeod, J. W., 118
McNattin, Robert F., 717
McPeak, Edgar M. 72
McPhedran, F. Maurice, 265
McRae, Colin C., 132
Mallet, L., 433
Maly, Henry W., 270
Manges, W. F., 565
Marinesco, G., 428
Markow, D. A., 276
Martin, Hayes E., 717
Martinotti, Giuseppe, 707
Maruyama, Kotato, 285
Marvin, Horace P., 113
Masturzi, Antonio, 827
Matthews, Helen, 411, 818
Matthews, W. B., 420
Mayneord, W. V., 138, 837
Meakins, J. C., 118
Melinte, 421
Meller, O., 425
Menard, O. J., 270
Menkes, 421
Menkes, Benedikt, 133
Merklen, Pr., 266
Merritt, Edwin A., 72
Meserve, F. G., 552
Meyer, Jacob, 417
Meyer, Karl A., 123
Meyer, Wm. H., 562
von Meysenbug, Ludo, 830
Michael, Paul, 422
Milch, Henry, 430
Milesi, Giuseppe, 836
Milkman, Louis A., 622
Miller, Leo F., 711
Milles, George, 124

Mills, Ralph G., 130
Mitchell, C. Leslie, 712
Moffat, Barclay W., 714
Mojarowa, E. N., 139
Moloy, Howard C., 563
Moore, Claude, 565
Moore, John J., 457
Morrow, Howard, 735, 738
Morse, Russell R., 569
Morton, Charles B., 708
Mossessian, Zaré, 714
Muscettola, Giuseppe, 821
Mutscheller, A., 92, 384
Muzii, Mario, 420
Myers, J. A., 114, 117

Naslund, Ames William, 569
Nathanson, Louis, 589
Neiman, Benjamin H., 608
Nemours-Auguste, 406, 707
New, Gordon B., 436
Newcomet, W. S., 737
Nichols, Bernard H., 52, 196, 259, 563, 713, 769
Niculescu, Petre, 706
Nielsen, Niels, 121
Nilsson, Folke, 831
Nilus, François, 831
Nordentoft, Jacob, 435
Norris, Charles, 292

Oechsli, Waldo R., 115
Opie, Eugene L., 265
Ormsby, Oliver S., 105
Osmond, Leslie H., 23
Osterberg, Arnold E., 130
Ott, Paul, 287
Ottonello, Pietro, 827
Overend, T. D., 121
Overgaard, Kristian, 838

Paggi, Gastone, 261
Palmieri, Gian G., 292
Palumbo, Vincenzo, 137
Pancoast, Henry K., 134, 259
Papadopoulos, Alexander S., 716
Parino, Adriano, 126
Peirce, C. B., 565
Pellissier, 834
Pemberton, Ralph, 430
Percy, Nelson M., 179
Perotti, Desiderio, 715
Perussia, Felice, 813
Peter, Gustavo, 135
Peterson, B., 377
Peterson, V. L., 564
Pfahler, George E., 274, 293, 565, 734, 738
Piccinino, Guido, 421
Pick, Ludwig, 710
Pigorini, Luigi, 573
Pirie, A. H., 145
Pirkle, H. B., 290
Pizzoglio, Ermete, 573
Poittevin, 832
Poli, Antonio, 826
Politzer, G., 284
Pollock, William C., 113
Polzien, F., 278
Pomeranz, Maurice M., 564
Poncher, Henry G., 124
Popesco, A., 269
Popp, L., 271, 435
Porta, Remo, 126
Portmann, U. V., 508
Potter, Eugene B., 132
Potter, H. E., 101
Poulain, 416
Pound, Robert E., 569
Püschel, Arnold, 274
Pulsford, Jean, 433

Quimby, Edith H., 534

Radovici, A., 425
Rathbone, R. R., 808
Reed, Edward N., 825
Reichle, H. S., 112, 822
Reimann, S. P., 706
Reinhard, M. C., 277
Resnik, Joseph, 189
Reynolds, Lawrence, 240, 558, 695, 811
Richards, G. E., 136
Ritvo, Max, 189
Roberts, J. E., 837
Roesler, H., 464
Rogers, W. L., 267
Rogoff, Jacob, 613
Rosh, Rieva, 82
Rosselet, A., 138
Rowe, Albert H., 271
Ryan, Clarence A., 555
Rypins, Edwin L., 823

Saltzstein, Harry C., 273
Sandblom, Philip, 416
Sandera, R., 835
Sante, L. R., 763
Saralegui, Jose A., 167
Sarasin, R., 421, 422
Saupe, E., 140
Schaefer, H., 282
Scharnagel, Isabel M., 831
Schiassi, Francesco, 427
Schinz, H. R., 128
Schmitz, Henry, 87
Schmitz, W., 282, 287
Schnyder, Walter F., 134
Schoenfeld, Herbert H., 565
Schreiner, Bernard F., 516
Schreus, H., 289
Schulte, G., 143
Schwartz, G., 817
Seabold, P. S., 706
Sedwick, H. Jobe, 154
Segre, Mario, 835
Severeano, J., 137
Shabet, L. Willard, 823
Shamaskin, Arnold, 613
Shapiro, Philip F., 272
Shdanow, D. A., 282
Shiflett, E. Lee, 52, 196, 713
Sichel, D., 266
Sievert, Rolf M., 280, 292
Silbermann, 834
Simon, René, 429
Simon, S., 273, 292
Simpson, Frank E., 738
Singer, Harry A., 112, 123, 823
Skillen, Jane, 115
Skinner, E. H., 738
Smith, Alan DeForest, 431
Smith, David T., 267
Smith, Harry L., 269, 270
Soiland, Albert, 434, 816
Sokol, Louis I., 116
Speed, J. S., 827
Stahel, E., 292
Stecher, Robert M., 431
Stephens, D. J., 824
Stewart, Chester A., 263
Stewart, William H., 43, 254, 566
Stewart, William J., 826
Stewart-Harrison, R., 136, 289
Stivelman, Barnet P., 264
Stoneburner, C. F., 524
Stout, Arthur Purdy, 500
Strauss, Alfred A., 417
Sussman, Marcy L., 128
Sutherland, C. G., 564
Svenningsen, O. K., 710
Sweany, Henry C., 114

Talini, Pier Carlo, 435
Taussig, Laurence R., 735
Taylor, Grantley W., 730, 734
Taylor, Henry K., 564, 589
Taylor, Lauriston S., 524
Thoma, K. H., 709
Thompson, Basil, 412
Thoyer-Rozat, P., 833
Tillier, R., 267
Timpano, Mario, 119
Tinker, Martin B., 139
Topcik, Aaron A., 273
Torelli, Gastone, 715
Torkildsen, A., 145
Trepiccioni, Emanuele, 261
Trostler, I. S., 680
Tunick, Isidor S., 564

Uehlinger, E., 128
Uhlmann, Erich, 282
Unseld, E., 275

Vajano, Domenico, 127
Valsecchi, Romeo, 263
Vastine, Jacob, 565
Veal, J. Ross, 64
Verano, G., 278
Vita, Giulio, 124, 707
Vitek, Jirl, 426
Vladescu, Violeta, 707
Volpe, Vito, 126, 419

Walker, A. Earl, 437
Wallgren, Axel, 291
Wallon, E., 830
Warfield, C. H., 563
Warren, Stafford L., 369
Waters, Charles A., 563
Weber, Harry M., 423
Wéber, Pierre, 704
Wehr, William H., 516
Weill, Joseph, 429
Wessler, H., 115
Wetherby, Macnider, 429
Wheatley, Frank E., 411
Whitman, W. G., 291
Widemann, Max, 287
Widmann, Bernard P., 211
Williams, Paul C., 713
Willius, Fredrick A., 269, 270
Wilsey, R. B., 789
Windholz, Franz, 428
Wishner, Joseph G., 716
Woldringh, B. M., 286
Wolf, M., 266
Woods, Robert C., 534
Wright, Lillie M., 430
Wulff, H., 277

Yglesias, Luis, 713
York, C. H., 822
Young, Barton R., 565

Zachrisson, Carl G., 836
Zweifel, C., 139
Zwerg, H. G., 142, 278

VOLUME XXXII DECEMBER, 1934 NUMBER 6

JAN 2 - 1935

[FOUNDED IN 1906 AS THE AMERICAN QUARTERLY OF ROENTGENOLOGY]

MEDICAL LIBRARY

The AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

OFFICIAL ORGAN
THE AMERICAN ROENTGEN RAY SOCIETY
THE AMERICAN RADIUM SOCIETY

Editor: LAWRENCE REYNOLDS, M.D.

Editorial Board

A. C. CHRISTIE, M.D. E. H. SKINNER, M.D. LAURISTON S. TAYLOR

Advisory Board for Pathology

JAMES EWING, M.D. EUGENE L. OPIE, M.D.

ISSUED MONTHLY FOR THE AMERICAN ROENTGEN RAY SOCIETY
BY CHARLES C THOMAS, PUBLISHER, SPRINGFIELD, ILLINOIS

AMERICAN ROENTGEN RAY SOCIETY

Thirty-sixth Annual Meeting *Atlantic City, N. J., Sept. 24-27, 1935*

AMERICAN RADIUM SOCIETY

Twentieth Annual Meeting *Atlantic City, N. J., June 10-11, 1935*

YEARLY SUBSCRIPTION, $10.00 INDEX NUMBER SINGLE NUMBER $1.50

SEASON'S GREETINGS 1934

DU PONT FILM MANUFACTURING CORPORATION
35 WEST 45TH STREET · NEW YORK CITY

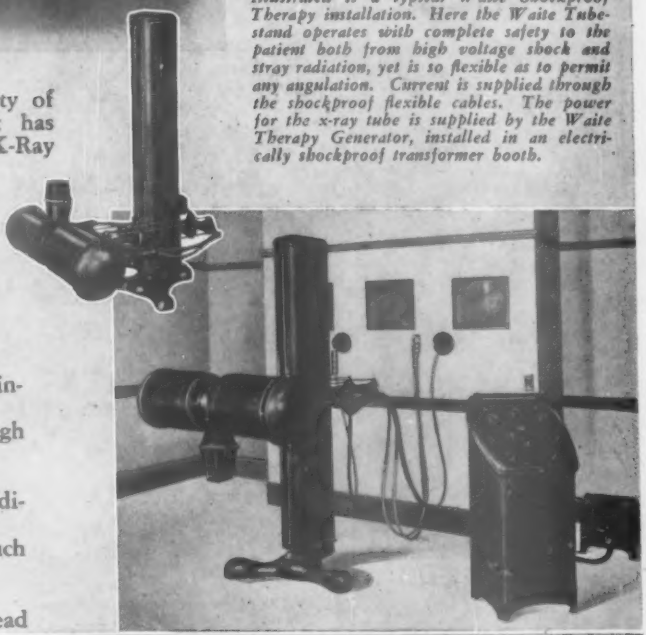
Installed and Operating
in leading institutions throughout
the United States

WAITE
Shockproof Rayproof
200 KV., 25 MA., THERAPY
***Flexible* TUBESTAND**

Illustrated is a typical Waite Shockproof Therapy installation. Here the Waite Tubestand operates with complete safety to the patient both from high voltage shock and stray radiation, yet is so flexible as to permit any angulation. Current is supplied through the shockproof flexible cables. The power for the x-ray tube is supplied by the Waite Therapy Generator, installed in an electrically shockproof transformer booth.

The safety, flexibility and dependability of the Waite Shockproof Therapy Unit has opened new fields of opportunity in X-Ray Therapy for Roentgenologists.

Write for the names of leading institutions where this new Waite Shockproof Flexible Unit has permitted the use of new techniques with exceptional success.



Completely shockproof up to and including 200 Kv. and 25 Ma.
Completely x-ray proof except through treatment port
Every conceivable angulation
Compression treatment with cone in direct contact with patient
Treatment above or below table or couch
Perfect counterbalance
Long-life x-ray tubes
Shockproof cables, eliminating overhead

Write for Bulletin 170, describing the complete line of Waite Therapy Generators and Shockproof Tubestands

PICKER X-RAY
CORPORATION

300 Fourth Avenue, New York • Superior at 30th Street, Cleveland • Other Offices in Principal Cities

FACTS
—to confirm
—to classify
Radiograph that shows exostoses in knee joint.
RELIABLE estimates place the incidence of arthritis at more than three times that of tuberculosis. Consequently, it is a condition that every physician meets frequently in his practice. Successful treatment demands early recognition of the disease and accurate classification as to type.
To diagnose and classify arthritis promptly and accurately . . . to obtain complete information, x-ray examination is essential. Radiographs show any erosion of the cartilage, effusion in the joint, periarticular swelling, or outgrowths of new bone formation. With this definite diagnostic data, you can quickly decide whether the condition is traumatic, infectious, atrophic, or hypertrophic.
Your radiologist alone can provide you with such complete, conclusive evidence. So refer your patient to him as soon as there are any clinical indications of arthritis.
"Radiography and Clinical Photography" will be sent free on request. Mail the coupon.
EASTMAN KODAK COMPANY
Medical Division
341 State Street, Rochester, N. Y.
I should like to receive "Radiography and Clinical Photography" regularly.
Name .....
No. & St. .....
City & State .....
RADIOGRAPHS PROVIDE DIAGNOSTIC FACTS

ARTHRITIS is the subject of this Eastman advertisement appearing in December medical journals. Again physicians are reminded to make full use of your services in arriving at their diagnoses • In making these radiographs, be sure to use Eastman *Ultra-Speed* Safety X-ray Film. It gives sharp contrast with speed. And, in addition, each film is exactly like the last—exactly like the next • Specify "Eastman *Ultra-Speed*" on all your x-ray film orders • Eastman Kodak Company, *Medical Division*, Rochester, N. Y.

EASTMAN *Ultra-Speed* X-RAY FILM